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OF THE
# Ministry of Agriculture

MAY, 1921.

PRINCIPAL CONTENTS.

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# CONTENTS.

# THE JOURNAL
## OF THE
# MINISTRY OF AGRICULTURE

Vol. XXVIII. No. 2.

MAY, 1921.


## NOTES FOR THE MONTH.

**Home-Grown Wheat Prices.**

An account was given in the March issue of this Journal (p. 1097) of the arrangements proposed to give effect to the Government's decision in regard to the price to be paid for home-grown wheat of the 1920 crop. The scheme has since been extended so as to enable sales made by growers to merchants between 8th November, 1920, and 5th March, 1921, to be dealt with more effectively. Farmers who sold wheat during this period to merchants can now claim the repayment of the difference between the price which they received and the prescribed price for wheat of sound milling quality. Claim forms containing instructions to growers in England and Wales can be obtained from the local branches of the National Farmers' Union and the National Association of Corn and Agricultural Merchants.

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**Home-Grown Wheat Prices for April and May.**

In connection with the arrangement as regards the price of home-grown wheat of the 1920 crop, it was stated that the price of 95s. per 504 lb. for home-grown wheat of sound milling quality will continue so long as the average c.i.f. cost of imported wheat remains above the parity of that figure. This average will be the average of the c.i.f. cost of all milling wheat imported during the two preceding months, together with the actual and anticipated arrivals in the United Kingdom during the current month, subject to adjustment in respect of the lower percentage of flour of equal water content obtainable from home-grown wheat as compared with imported wheat. In the event of this average falling below the equivalent of 95s. the price of home-grown wheat will be adjusted accordingly, and the revised price to be paid by millers will be announced monthly.

(36771) P6/198. 11,250. 4/21. M. & S.

The Ministry announced on the 23rd of March that it had been informed by the Ministry of Food that the average c.i.f. cost of imported wheat calculated as stated above for the month of March was 102s. 7d. per 480 lb. After making the necessary adjustment for moisture content, the equivalent price for home-grown wheat is approximately 96s. 3d. per 504 lb. The price of 95s. per 504 lb. payable by millers therefore remained unaffected during the month of April.

As regards the price payable during the month of May, the Ministry is informed that the Royal Commission on Wheat Supplies calculate that the cost of wheat imported during February, March and April is equivalent to 92s. per qr. of 504 lb. for home-grown wheat of sound milling quality. For the month of May, 1921, therefore, the average price properly receivable by growers will be 92s. per 504 lb.

Special arrangements have been made which should enable millers to use home-grown wheat freely and to pay for it on the average a price not less than the price properly receivable by growers for wheat of average quality. Choice samples should realise prices above the average, but lower prices can only be expected for samples of inferior quality or condition.

No definite guarantee can of course be given that millers will be able to purchase all the home-grown wheat that may be offered to them at any given time, especially if farmers press their wheat on the market in excess of normal requirements, but the Ministry does not doubt that the whole of the wheat crop is required and that it will have been absorbed by the mills by 13th August next, the date at which the present arrangement will come to an end.

* * * * * *

**Export of Worn Out Horses.**

MANY complaints have lately reached the Ministry from those who have seen or heard that British horses landed in Belgium are too often in a condition that should have precluded their export. For some time past the Ministry has been conducting a very careful investigation into conditions in Belgium and at our home ports, and as a result it was ascertained that while the standard at the Port of London is uniformly high, certain cargoes which have been allowed to leave provincial ports have contained horses which in the Ministry's opinion did not conform to the standard set up by the Act of 1914. In order to secure the greater supervision which is necessary in order to maintain humane conditions, it has been decided to employ an additional Staff of Veterinary Surgeons who will give their whole time to this work.

It is very generally admitted that the Act of 1914 has to a large extent removed from export the class of horse that made up a very considerable part of the consignments before the War, and it is hoped that the fresh action taken will still further secure the observance of the Act. Every effort is being made to stimulate the slaughter by humane methods on this side of horses that are intended for meat. It is proposed to extend this system to the fullest possible extent so that no horse intended for consumption may be sent across the seas alive. The extent to which horse-slaughtering depôts in this country have developed near the ports during the past six months is most encouraging and favours the belief that home-killing will soon become the rule and the export of live horses for meat a rare exception. At the same time it is well to remember that a horse in all respects fit for work may be bought in Belgium for meat, because horses are sold in the open market and the butcher may be prepared to outbid other buyers.

* * * * *

**A Successful Prosecution under the Swine Fever Order.**

In Glasgow last month a pig feeder was charged and found guilty of having had in his possession a number of pigs affected with or suspected of having Swine Fever and failing to give notice of the outbreak to the authorities. He was further charged and found guilty with having exposed twenty pigs for sale in one market and fifteen pigs for sale in another market, all these pigs being diseased or suspected of being diseased. Nearly all the pigs disposed of in the markets had died of Swine Fever within a short time of the sale. The Court imposed a fine of £100 with two months' imprisonment as an alternative. The Ministry of Agriculture through its inspectors has traced the pigs that this dealer sold, and of the fifteen sold on the 8th December all were suffering from Swine Fever ten days later. The twenty sold on 6th December were disposed of to different farmers and introduced Swine Fever on eight sets of premises. The very serious injury which is done to the pig breeding industry by cases of this sort will be realised, and it is the duty of every pig keeper to see that he does not sell any animals which afford any suspicion of the existence of Swine Fever. In this trade as in all others there is a certain amount of wilful carelessness, even of fraud, but if the Petty Sessional Courts before which cases like the one referred to above are brought, will only deal with them on the same salutary lines it

is safe to say that the business of trading suspect animals will become unpopular.

* * * * * *

**Building for Land Settlement: A Survey of the Ministry's Work.**

EARLY in April Sir Lawrence Weaver, Director-General of the Land Department of the Ministry of Agriculture, read to the Royal Institute of British Architects a paper in which he set out a brief record of the Ministry's work in providing land settlement for ex-soldiers. He pointed out that this work is the outcome of a pledge given during the war to men in H.M. Service and to women who worked on the land for at least six months. This pledge received statutory force from the Land Settlement (Facilities) Act of 1919.

The total applications from ex-Service men for land amounted to 48,340 when the list was closed on December 1st last. It is expected that about 30,000 of these applications will stand and of these upwards of 11,000 have been satisfied. If agricultural conditions continue satisfactory enough to maintain the pressure of applicants' demand for land it may be found necessary to acquire as much as 160,000 acres more, so that when the work comes to an end 640 square miles will have been acquired and 30,000 men will have been settled.

The term "Small Holding" is an elastic one and covers anything between a plot of an acre or two suitable for a market garden up to a fifty acre dairy holding with seven roomed cottage, dairy and farm buildings. The capital cost has ranged from £100 to £5,000, but is now limited to £2,500. The average size of a holding in England and Wales is about 13½ acres. Practical difficulties in the way of work done have been immense. Demobilisation brought no reduction in the cost of building; contrary to general expectation prices increased. Although the Land Settlement (Facilities) Act placed twenty million pounds to the credit of capital costs and although the Government undertook to meet all annual losses, the most rigid economy has been called for all the time. Approximate scales of capital cost and annual loss per holding were placed before the County Councils in the summer of last year, and the Ministry's superintending architects review all small holding building schemes and cut out every item of unnecessary expenditure.

The Land Settlement Division maintains the closest

relationship with County Councils, and the Ministry's District Commissioners act with the superintending architects "as ambassadors to the County Councils." Experience has shown that cheap architects make poor buildings, and the Ministry urges upon County Councils the engagement of men with proper qualifications. In view of the bitter need for reduction in cost, it has been found that the architect in charge of cottage and farm building schemes must needs be more of an organiser and economist than an artist. The complete task of the Ministry which is, working through the County Councils, to provide three thousand new cottages and nearly two thousand sets of new farm buildings, in addition to hundreds of adaptations of existing premises, is complicated by the fact that the work is spread over sixty-two administrative counties "in remote Yorkshire vales, on the slopes of Welsh mountains, in the folds of inaccessible downs." The whole of the architectural work has been carried on as far as the Department is concerned by less than fifty people and the best possible use has been made of the very limited range of available material. In building operations it has been found that brick has held its own, though most exhaustive experiments have been made with cob, pisé and concrete.

The Ministry looks forward to the time when it will no longer need to control directly the building operations on its own Farm Settlements, which amount to 25,000 acres. It takes the view that building is a commercial business associated with a speculative side and carrying with it risks that a Ministry ought not to undertake. A Government Department is concerned with administration and not with trade, nor can it hope to carry on business successfully because the Treasury supervision, which is absolutely essential in the best interests of the State, enforces delays and difficulties which the ordinary building contractor does not encounter. This view is explained in greater detail in the Report of Proceedings under the Small Holdings Colonies Act for the period ended 31st March, 1920, in which it is explained that a decision has been arrived at:—

(a) To divide into small holdings the area now devoted to central farms on small holdings settlements, and to dispense with the services of the Director so soon as the equipment of the whole estate for small holdings purposes has been completed and the settlers are fairly established.

(b) To transfer the management of such estates to the Councils of the counties in which they are situate.

(c) To deal with the profit-sharing farm settlements in one of the following ways: (1) Where the land is suitable, by cutting up part of the estate into small holdings, and by selling the remainder as ordinary farms; (2) By selling the complete estate; (3) By retaining one, or at most two, specially favourable estates (in whole or in part) in order to draft thereto men displaced on other estates.

* * * * * *

**Rations for Live Stock.**

No. 32 of the Miscellaneous Publications of the Ministry is by Professor T. B. Wood, of Cambridge University, and is called "Rations for Live Stock." It shows the composition and nutritive value of many feeding stuffs, the relation between live-weight and food requirement, and offers the farmer a method of working out suitable rations for his animals. Professor Wood compares an animal with a steam engine at work and points out that it must be supplied with the materials necessary for fuel and repairs, the fuel of the animal being carbohydrates and fats or oils, while the repairing material is given in the form of albuminoids or flesh formers. He emphasises the important fact that the value of the feeding stuff depends on the proportion that can be digested, and the pamphlet contains figures giving the nutritive value of a large number of foods and the nutritive ratio of the repair to the fuel content. Then comes the question of productive feeding—the food that will enable animals to increase their weight, yield more milk or do more work. Advice is offered on the question of buying feeding stuffs, and figures are supplied giving the best measure of the relative productive value of various concentrated foods.

An important section of the pamphlet is that dealing with the general properties of feeding stuffs. It is followed by notes on the rations for fattening bullocks, for cows, calves, sheep, horses and pigs. Professor Wood has used the simplest possible language and has been so careful to explain the principles underlying the tables accompanying the pamphlet that a very small effort is required to master them. The value of these contents to the practical agriculturist is undoubtedly very great. Even some of our successful stock owners may find in the light of this work that they have been feeding wastefully and that a better balanced ration may add to the worth and condition of the stock fed.

**Minimum Prices for Wheat and Oats Harvested in 1921.**

THE procedure in regard to the minimum prices guaranteed by the Agriculture Act, 1920, in respect of wheat and oats produced in 1921 was explained in the April issue of the JOURNAL (p. 8). The attention of farmers is drawn to the fact that no payment will be made unless a claim is made in respect of the area on which the wheat or oats have been produced. Forms of claim for 1921 will be issued along with the forms on which the Agricultural Returns have to be made on 4th June, 1921. The claims must be forwarded direct to the Ministry of Agriculture and Fisheries not later than the 30th June, unless the claimant can show that he became the occupier of the land after that date, in which case the Minister may accept a claim made not later than the 1st September, 1921.

The claimant will be required to enter on the form of claim particulars of each separate field of wheat or oats. The number of each field as shown on the 25-inch Ordnance Survey Map, and the ploughed area of wheat or oats in each field, will have to be stated. These detailed particulars are necessary to enable the Ministry and the County Agricultural Committee to verify the accuracy of the claim.

Copies of the Ordnance Survey Map on the 25-inch scale can be purchased through any bookseller, price 5s. per sheet. In most districts copies of the map of the district can be inspected at the office of the County Agricultural Committee. Information as to the number of fields can also be obtained at the local office of the District Valuer of the Board of Inland Revenue. The Assistant Overseer may also possess a copy of the map of his parish. In case of difficulty, inquiry should be made of the Cultivation Officer of the County Agricultural Committee. Farmers are advised to take steps forthwith to ascertain the numbers of the fields sown or intended to be sown with wheat or oats as shown on the 25-inch Ordnance Survey Map.

# ACCOUNTS OF A HAMPSHIRE DOWN FLOCK.

SIR A. D. HALL, K.C.B., F.R.S.

IN this JOURNAL for May, 1920, the accounts of the Pedigree Hampshire Down Flock belonging to the Lord Wandsworth Orphanage and kept on their Long Sutton Estate in Hampshire were set out for the year ending Michaelmas, 1919. Below are set out the corresponding figures for the following year, ending Michaelmas, 1920.

*Cr.*

| *1919, 11th Oct.* | £ s. d. | £ s. d. | £ s. d. | *1918/19.* £ s. d. |
|---|---|---|---|---|
| To Capital a/c 11th Oct., 1919— | | | | |
| 261 Ewes at £4 .. .. | 1,044 0 0 | | | |
| 4 Rams at £7 .. .. | 28 0 0 | | | |
| Half cost purchased ram .. | 78 15 0 | | | |
| Cost hired ram .. .. | 52 10 0 | | | |
| Keep, May 1st, Oct. 11th .. | 583 0 0 | | | |
| 69 Ewe Lambs { at cost on May 1st } | 760 11 0 | | | |
| 20 Ram Lambs { May 1st } | | | | |
| Keep, May 1st, Oct. 11th .. | 206 6 8 | | | |
| | | 2,753 2 8 | | 2,812 16 4 |
| Labour .. .. .. .. | | 537 8 0 | | 405 13 5 |
| Horse Labour .. .. .. | | 87 19 6 | | 88 4 6 |
| Purchased foods consumed .. | | 1,462 0 11 | | 662 8 9 |
| Roots, Vetches, Kale, etc., consumed, at cost .. .. .. .. | | 977 19 8 | | 673 16 7 |
| Fields grazed, at cost .. .. .. | | 139 13 6 | | 74 9 0 |
| Hay consumed, at market price £13, plus tying 5/2d. .. .. .. | | 566 10 8 | | 402 16 3 |
| Oats, Beans consumed, at market price | | 160 10 7 | | 295 7 2 |
| Sundries .. .. .. .. | | 204 4 7 | | 161 11 9 |
| Management and other general expenses | | 250 0 0 | | 256 3 5 |
| Ram lambs purchased (3) .. .. | | 435 15 0 | | 157 10 0 |
| Ram Lamb hired .. .. .. | | 52 10 0 | | 52 10 0 |
| Pedigree Suspense a/c. 1/3 Cost 40 ewes, ½ Cost 1 Ram. | | 321 19 11 | | |
| | 7,949 15 0 | | 6,043 7 2 | |

*Dr.*

| *1920.* | £ s. d. | £ s. d. | *1918/1919.* £ s. d. |
|---|---|---|---|
| By Ram Lambs Sold (73) .. | | 1,776 2 7 | 903 16 4 |
| Fat Sheep and Lambs (146) .. | | 895 1 4 | 1,108 0 5 |
| Shearlings (20) .. .. | | 374 14 2 | 255 7 6 |
| Wool, 2,395 lb. at 39½d. | | | |
| 322 lb. Lambswool at 44d. | | | |
| 417 lb. Tarlings at 5d. .. | | 452 7 5 | 326 18 10 |
| Manurial Residues .. .. | | 537 4 7 | 335 7 2 |
| Sundries.. .. .. | | 60 10 2 | 36 2 6 |
| Pedigree Suspense a/c. ½ cost Rams | | 217 17 6 | |
| Valuation, 11th Oct., 1920— | | | |
| 263 ewes at £4 on May 1st, plus cost of keep to Oct. 11th .. | £1,170 10 0 | | |
| Cost hired Ram .. .. | 52 10 0 | | |
| ½ cost 3 Ram Lambs .. | 217 17 6 | | |
| 3 Rams at £7 .. .. | 21 0 0 | | |
| 16 Rams Lambs } at cost<br>90 Ewe Lambs }<br>47 Tegs } | 1,983 6 0 | | |
| | | 3,445 3 6 | 2,753 2 8 |
| Loss.. .. .. .. .. | | 190 13 9 | 324 11 9 |
| | 7,949 15 0 | | 6,043 7 2 |

It may be explained again that the accounts are kept on a costs basis. The initial valuation is arrived at by taking the number of flock ewes on 1st May (approximately the date of weaning) at the average figure of £4 each. Old rams are similarly valued at £7 each. From 1st May the cost of keeping (a) the ewes, (b) the selected ram lambs, (c) the ewe lambs and wethers is kept separately, and the valuations at Michaelmas are made up of the flock ewes at their fixed £4 price and the cost of keep between 1st May and 11th October, any ram lambs remaining unsold at cost, also ewe lambs and tegs at cost. The valuation figure has also to include the cost of any rams hired for the coming season, and one-half cost of rams purchased. For book-keeping purposes a pedigree suspense account is kept which is debited with the cost of ewes and rams purchased for the flock. one-half of the ram costs are charged to the flock in each of the two years after purchase, and the cost of the ewes is similarly spread over three years. The labour and horse labour items represent actual costs; the crops that are folded off are charged at two-thirds of the cost of cultivation, plus the cost of seed (the manures and one-third of the cultivation, as representing cleaning costs, are passed on to the succeeding corn crops); hay, oats and other foods grown on the farm are charged at market prices.

An examination of the figures for the two years shows that the costs of keeping the flock, high as they were in 1918-19, have been greatly increased in 1919-20. The cost of the labour directly employed upon the flock (one head and one assistant shepherd and one labourer) has increased from £406 to £537. Similarly the cost of the crops consumed, again largely labour, has increased from £673 to £978. The chief increase in the expenditure comes, however, in the purchased foods, the cost of which has risen from £662 to £1.462. To some extent this has been due to a large number of lambs raised and to increased prices, but the extra cost has been chiefly due to the fact that during the year in question feeding stuffs were again obtainable in quantity and were consumed on the principle of " no stint " and " the best is good enough for me " which prevails in the rearing of pedigree stock. Less home grown oats and beans were used, the grazing (92 acres of lattermath) on the other hand cost rather more, but this cost is accidentally swelled by a very heavy bill for fertilisers charged to the pastures, on which a course of improvement is being carried out. Less hay was consumed, but at the price then ruling, £13, the cost amounted to £566 as compared with £402 in the previous year.

The general result is a very heavy expenditure; taking the ewe as a unit the total cost of the flock per ewe amounted to £16 3s. in 1919-20 as compared with £9 5s. in the preceding year. Of this £10 12s. went for food, £2 8s. for labour, £1 8s. for rams, &c., £1 15s. for management and sundries, as compared with £5 15s. for food, 26s. for labour, 17s. for rams and 27s. management and sundries in 1918-19. These figures are very large in themselves, apart from the enormous increase they show on those of the preceding year. To some extent the increase is due to a bigger number of lambs reared, 304 against 278, and particularly a bigger number of ram lambs, which cost the most, 89 against 58 in the preceding year. Labour and food were dearer. The extra 8s. per ewe for sundries represented only the increased cost of showing in 1920 as compared with 1919. Big as the food bill appears it is not a wasteful one, such as might be incurred by a shepherd who dips at will into granary and cake store; the foods are rationed out after discussion between the manager and the shepherd, and while there has been no stint there has been no waste. I am satisfied that the costs are legitimate enough for the year and do not exceed those prevailing in other pedigree flocks of the same quality.

Of course there are probably no other sheep so expensively produced; Hampshire ram lambs have to be forced from birth, indeed as much as possible before birth, because neither breeding nor quality will be of much avail if the lambs have not size at the August sales. The essence of a Hampshire is early maturity and the ram buyers make their choice on what they see before them, which is, other things like conformation and wool being equal, the weight attained in the time, whether that is due to skilful feeding and to natural capacity to put on flesh such as may be transmitted to the offspring. I am aware of few pedigree flocks that have a strict account kept against them, especially as they so often are kept as hobbies; indeed, the main purpose of setting out this account is to induce owners of pedigree flocks to realise what expenditure they are up against.

On the credit side the flock makes a better showing in 1919-20 than in the preceding year. In the first place more lambs were reared, 310 from 263 ewes, as against 278 from 279 ewes in the preceding year, and the quality was better, so that 89 could be drafted for the ram sales as compared with 58 before. Sales were better; as is well known, there was an exceptional recovery in the demand for rams and sheep of all kinds in 1920. This

flock in 1920 let two lambs at 225 and 150 guineas respectively, and sold three others at 82, 54, and 48 guineas, the average for 73 lambs being over £24, while the 20 shearlings averaged nearly £19 each. The draft ewes and the butcher's lambs made over £6 each as compared with 73s. in the previous year. The wool, of which the ewes clipped over 8 lb. and the lambs under 3 lb., produced £452, as against £327. The valuation of the flock shows a considerable rise, nearly £700, but this was not due to any writing up of the value of the ewes, which would have been done in an ordinary valuation according to market prices, but to the fact that 47 tegs had not been sold by the 11th October (afterwards realising £306), that there were 11 more flock lambs kept over, and that the pedigree costs for rams hired and purchased had been increased by £140, and that the cost of keep from 1st May had been greater.

The final result shows a loss of £190, a sufficiently disconcerting result for what had seemed to be a good year, when the fall of lambs had been good, the early spring favourable, and the sales both in amount and quality far better than the flock had hitherto realised. Of course the loss could be converted into a profit if the hay, charged at market price—£13, were charged at cost, *i.e.*, at something under £4. Then the debit of £566 would become £176. In the oats and beans bought from the farm is also concealed a little profit. If all the home grown foods were charged at cost the account would show a nominal profit of £250 instead of a loss of £190. Argument will of course be perennial whether it is more correct to charge the live stock at cost or market price for home grown foods; it does not matter much except in times like the present when market prices are fluctuating widely. The important thing is that the farmer, using his book-keeping for his own information, should not deceive himself. The final upshot of the accounts of this flock, whether home grown food is taken in at cost or market price, comes to the same thing, viz., the flock produced from 171 acres of arable land cropped with roots, vetches, &c., 40 acres of seeds as hay, 8 acres of oats and beans, and 92 acres of lattermath, a cash return of about £250 after all expenses had been paid. The flock is only valued at about £3,000 at Michaelmas, but taking the average of the net expenditure also standing against it throughout the year it ought to be paying interest on a sum of about £5,000 floating capital. The result then could be summed up as showing that the flock returns a bare 5 per cent. on its capital while the land which the flock used, some 220 acres, earned no profit at all.

Now the land under corn on the same farm that year made an average profit of £4 12s. an acre, and it is in the light of this figure that the really unprofitable nature of the flock is seen. Land which will produce a profit of £4 12s. an acre under corn will produce no profit at all but only a low rate of interest on the extra capital at stake when its produce is marketed in the form of a pedigree flock.

It may be urged that the corn could not be grown but for the sheeping the land had received. The proposition is debatable, but at any rate the flock gets ample credit for what is done in this direction, because the subsequent crops have to pay off some £3 an acre of manurial residues in addition to £2 an acre or so of cleaning costs. While there can be no doubt about the enrichment of the soil effected by the heavy cake and corn feeding accompanying its folding over by a pedigree flock it is often difficult to get a paying return for this manuring. If the fold is late in March or even February, it is often difficult to get spring corn sown on a satisfactory tilth in time to secure a good crop, one that is in any way proportional to the manure residues supposed to be in the land. On these chalk soils the spring drought may set in early, and the two dominant factors in securing a good crop are early sowing and a good tilth. Actually on this farm wheat is the profitable crop rather than spring oats and barley, because it does not suffer from the late tilth and has not to pay so much of the costs carried over from the folding. In fact the corn is most profitable on the land that is never sheeped.

Another objection may be taken to the general conclusion as to the unprofitable nature of the flock—that it is not quite big enough nor skilfully enough managed to attain the results that alone will pay for the expense involved. The prices realised for pedigree rams by a flock which is recognised as among the two or three leading flocks in the country, the sort of flock which wins first prizes at the Royal Show, are very different from the prices obtained by a flock which just misses the highest position. Such a position has not been attained by this flock, whose show record for 1920 was one third prize at the Royal Counties Show, two second and two third prizes at the Bath and West Show, and one second prize at the Hampshire Down Society's Breed Show. The truth of both objections may be admitted. A flock of 400 or 500 has a much greater chance of winning prizes than one of 260, merely because there are more to select from. The expenses increase with

numbers but the whole average of the sales may be increased by the superior prize winning capacity. Again prize-winning to a considerable extent depends upon the art with which the stock are finally prepared and presented for show, and in connection with every breed there are two or three shepherds known for their personal skill in putting their animals before the judge to the best advantage. However, let it be admitted that the flock in question may fail in this respect, the general conclusion would still emerge that ram breeding is an unprofitable business unless the flock can be brought to the very top of the tree.

In fact one cannot standardise a ram breeder's business and prepare an account which compares the average cost of production with the return for the output that may be expected in a normal market. On the receipt side of the account the personal factor counts for much; how well can the particular shepherd show his sheep, how clever a salesman is the owner in the special and limited market in which he had to make his profit. But these accounts do show what costs of production have to be faced and how unprofitable a business ram breeding is likely to be for the majority of men who engage in it. The balance sheet may serve the purpose of inducing ram breeders to consider their business in the light of results; can they so bring their flock to the front as to pay for the expenditure or is the loss worth while as a luxury?

# RESEARCH IN ANIMAL BREEDING.

## II.

R. C. PUNNETT, F.R.S.,
*Professor of Genetics, University of Cambridge.*

*In the first article of this series, published in the April issue of the* JOURNAL, *Prof. Punnett dealt with coat colours in cattle as an illustration of simple Mendelian inheritance.*

IN the case selected for illustrating simple Mendelian inheritance, viz., black and red coat colours in cattle, one of the members of the alternative pairs of characters is completely dominant to the other. The black animal that carries red germ cells is quite as black in appearance as the true breeding black that carries black germ cells only. This feature of complete dominance is found frequently in animals, but there are other cases in which it is possible to distinguish by appearance, the form that carries both kinds of germ cells. Roan Shorthorns provide an illustration.

No breeder has succeeded in establishing a strain breeding true to roan, for such animals, when bred together, always throw reds and whites in addition to roans. Statistical examination of the herd books by several writers suggests that two kinds of germ cells are concerned, viz., " red " and " white." When two " red " germ cells meet, a red* animal results, and such animals breed true to red; also, when two " white " germ cells meet, the result is a white, and such animals breed true to white. When, however, a red is crossed with a white, as shown in Fig. 3, a union is effected between a " red " and a " white " germ cell. The resultant animal is a roan, more or less intermediate in appearance between full red and white. This animal, formed by two unlike germ cells, carries both " red " and " white " germ cells in equal numbers; consequently, when roans are mated together equal numbers of " red " and " white " ova are fertilized by equal numbers of " red " and " white " sperms. Each red ovum has an equal chance of being fertilized by a " red " or by a " white " sperm; in the former case it will give a pure red animal, and in the latter a roan. Also, each " white " ovum has an equal chance of being fertilized by a " red " or " white " sperm; in the former case a roan animal will result, and in the latter a white. Roans mated together, as shown in

* Both reds and roans may have white markings, especially on the belly, but these appear to be independent of the roan character.

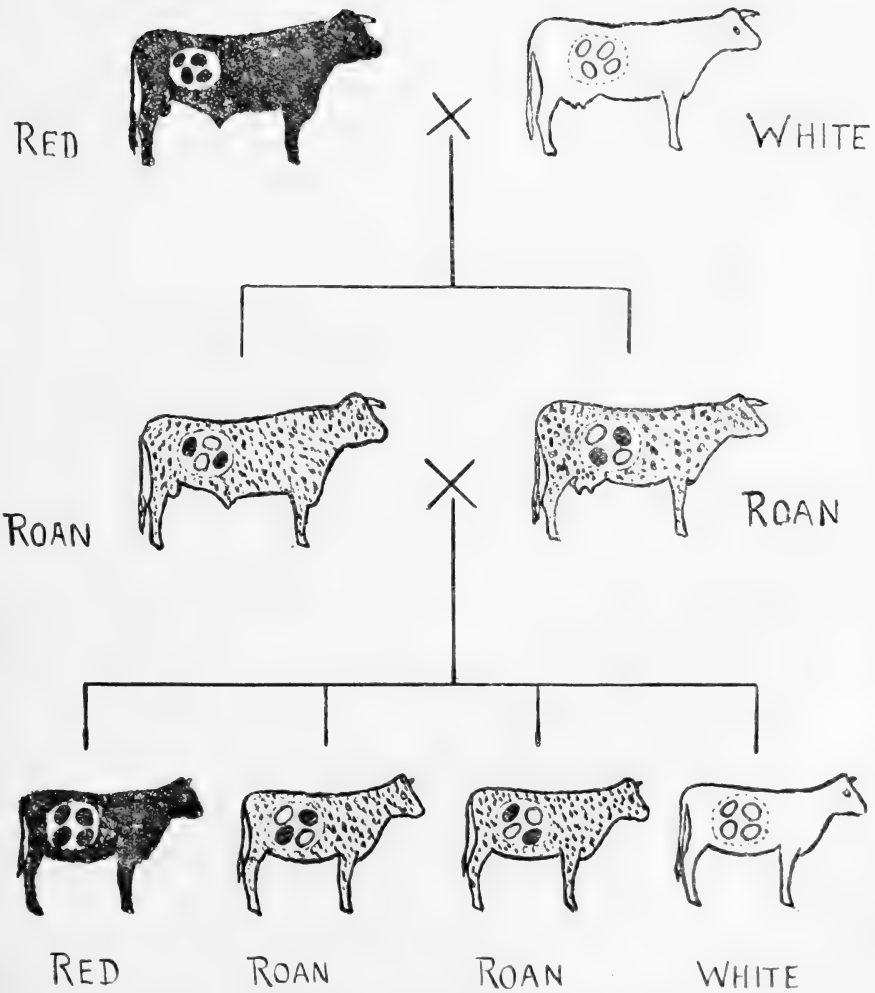



FIG. 3.—Illustrating the relations of Red, White and Roan.

Fig. 3, give reds, roans, and whites in the ratio 1 : 2 : 1. From the view of the practical breeder a roan animal is a hybrid between red and white; the colour cannot be fixed, for there are no "roan" germ cells (only "red" and "white" cells). The breeder who desires roan animals will be well advised to obtain them by crossing red with white; in this way 100 per cent. of roans will result, as against 50 per cent. from mating roan by roan, roan by red, or roan by white.

The "breaking up of the type" that often occurs after a cross is a familiar feature to breeders. The first cross animals may show considerable uniformity, though differing from both parental strains. In one character they may take after one parent, in another they may resemble the other parent, while in a third they may be more or less intermediate between the two. When such animals are bred together a great diversity of forms makes its appearance in the next generation, and in extreme cases scarcely any two beasts may be alike. The skilled breeder,

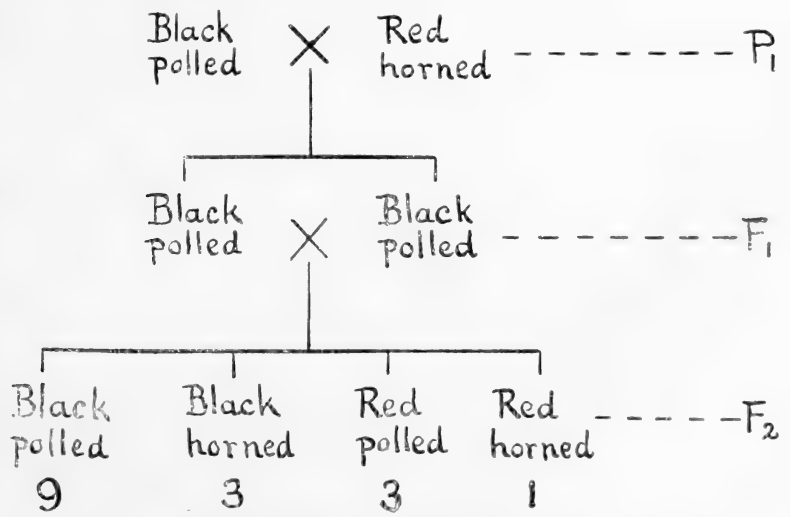



FIG. 4.—Illustrating the relations of Polled and Horned cattle.

however, will often name with certainty the original parental breeds of such a mixed progeny, as he will understand that there is something orderly underlying apparent chaos. The breeder who sees as far as this will doubtless welcome the simple explanation that Mendelism affords, but for those who may doubt the possibility of such an explanation, a simple example is given to illustrate the nature of the principle involved.

Suppose a cross is made between a black polled and a red horned breed. The progeny will be black polled animals (see

Fig. 4). The F1 generation is uniform, but when a further generation is raised from these, fresh types appear. In addition to black polled and red horned beasts there will be horned blacks and polled reds, types distinct both from parents and grandparents, but evidently a recombination of characters found in the grandparents. These four types appear in widely different proportions, as indicated by the numbers in Fig. 4. It has been pointed out already that polled and horned cattle form a pair of alternative characters, of which polled is dominant; and that black and red form a similar pair, the black being dominant. Knowing this, we should expect all the F1 beasts to be both black and polled; the F2 generation to consist of blacks and reds in the ratio 3 : 1, and polled and horned in the same ratio. If we suppose that the factors for the black-red and the polled-horned pairs are transmitted in the same manner, *but independently of one another,* we must obtain a F2 generation consisting of the four classes black-polled, black-horned, red-polled and red-horned in the ratio 9 : 3 : 3 : 1. This is the only ratio in which the polled and horned appear in the proportion 3 : 1, and the blacks and reds simultaneously in the same proportion, provided that each pair is inherited independently. Though the ratio 9 : 3 : 3 : 1 has not been verified on a comprehensive scale for the cattle cross, it has been worked out in all details in many cases for smaller animals, where the expenses of breeding are far less. There is reason for supposing that if a F2 generation of several hundreds of cattle were bred from this cross, the four classes mentioned would be obtained in the proportions given above.

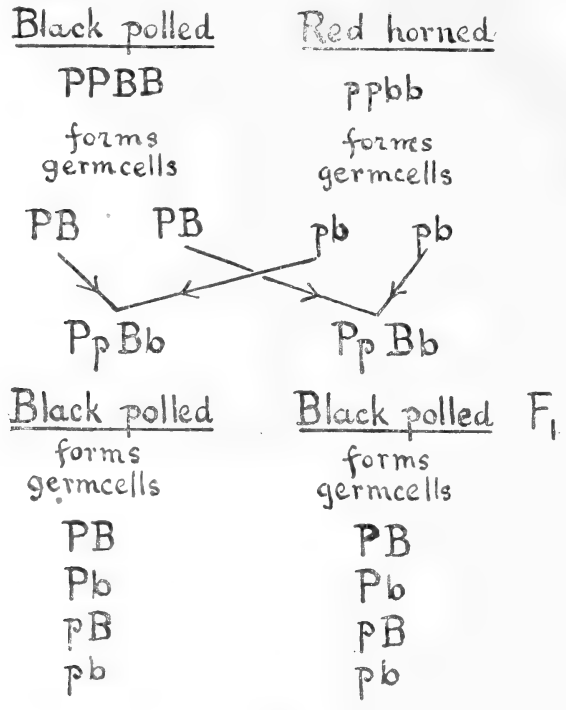
There has been a " break-up " of the parental types in that the two new classes, horned-blacks and polled-reds appear in the F2 generation; and it is clear that these new classes arise through recombination of the two pairs of factors in which the original parents differed. The " break-up," however, is not marked, because the parents differed in two pairs of factors only. Had they differed in ten pairs, the F2 generation would have been very much more complex, and the feature of recombination, so obvious in the simpler case, would have been obscured by the great number of recombinations that would have appeared. Nevertheless, on the evidence obtained from smaller animals, there is good reason for supposing that the more complicated case could be resolved on the same lines as the simpler one, and that the same principle underlies both.

A cross may be undertaken deliberately with the idea of combining particular characters found in one breed with other cha-

racters found in another breed, and with this in view it is clear that Mendelian principles can be of great assistance to the breeder. Let us suppose that the breeder wishes to obtain a strain of red polled cattle out of Aberdeen Angus and Red Shorthorn; and further, that he is not aware of the fact that polled and horned, and black and red behave as simple Mendelian pairs. From this crossing only polled blacks result. So far he can say only that the Angus is prepotent; but as soon as he raises a F2 generation and views it in the light of Mendelian knowledge, he begins to understand what is happening. The fact that he gets no intermediates, but only blacks and reds in the F2 generation, and that the latter form about one quarter of the total, tells him that these colours depend upon a single pair of factors. From the point of view of horns in the F2 generation, it will be noted that polled and horned appear in the ratio 3 : 1; and this tells the breeder that he is dealing with another pair of factors. Moreover, the 9 : 3 : 3 : 1 ratio tells him that the two pairs are transmitted independently; for this is the meaning of the 9 : 3 : 3 : 1 ratio in analysing the phenomena of heredity.

Having obtained the polled reds the breeder wants to fix them in the shortest time. To a problem of this sort Mendelian theory may be a valuable guide. When once the factors concerned in a cross have been determined, it is possible to calculate the proportion of fixed animals in each class of the F2 generation, and to suggest also how they are to be found. In explanation we may examine the cattle cross from a slightly different point of view. The nature of the F2 generation tells us that we are concerned with a difference of two pairs of factors, viz., the pair for polled and horned denoted by *P* and *p*, and the pair for black and red, *B* and *b*.* It is clear that both dominants went in with the Angus and both recessives with the Shorthorn: therefore, we denote the polled black as *PPBB* and the Shorthorn as *ppbb*. Since the F1 gets *P* and *B* from its Angus parent, and *p* and *b* from its Shorthorn parent, its constitution must be *PpBb* (Fig. 5). When F1 forms germ cells each cell contains a representative of the *P*-*p* pair, and also a representative of the *B*-*b* pair. Hence 50 per cent. contain *P* and 50 per cent. contain *p*: also 50 per cent. contain *B* and 50 per cent. contain *b*. Since the F2 generation shows that the *P*-*p* pair and the *B*-*b* pair are transmitted independently, we must suppose that any germ cell containing *P* has an equal chance of containing either *B* or *b*, and similarly, any *p* germ cell has an equal chance of containing *B* or *b*. Hence

* It is customary to denote the factor that gives rise to the dominant of a pair of alternative characters, by a capital letter, and that upon which the recessive depends, by the corresponding small letter.




giving rise to an $F_2$ generation :—

| | | | |
|---|---|---|---|
| PB 1. PB<br>Black polled | PB 2. Pb<br>Black polled | PB 3. pB<br>Black polled | PB 4. pb<br>Black polled |
| Pb 5. PB<br>Black polled | Pb 6. Pb<br>Red polled | Pb 7. pB<br>Black polled | Pb 8. pb<br>Red polled |
| pB 9. PB<br>Black polled | pB 10. Pb<br>Black polled | pB 11. pB<br>Black horned | pB 12. pb<br>Black horned |
| pb 13. PB<br>Black polled | pb 14. Pb<br>Red polled | pb 15. pB<br>Black horned | pb 16. pb<br>Red horned |

FIG. 5.—Illustrating the relations of Aberdeen Angus and Red Shorthorn.

the F1 animals will produce the 4 kinds of germ cells *PB*, *Pb*, *pB* and *pb*, and produce them in equal numbers. When F1 beasts are mated together it means that we are bringing together a series of ova of this nature with a similar series of sperms. The simplest way to arrive at the result is to make a figure of 16 squares, as shown in Fig. 5, and to write the above series of germ cells first across the four horizontal rows of the figure, and then down the four vertical rows of the same figure. This will give all the different possible combinations in the proportions in which they may be expected to occur, *i.e.*, the constitution of the F2 generation. Examination of the squares shows that 9 out of the 16 contain both *P* and *B* and are, therefore, polled blacks, 3 contain *B* and *p*, which are horned blacks; 3, in which *P* is associated with *b*, are polled reds; while 1, having only *b* and *p*, must be red horned. The three red polled are not all alike. One is *PPbb* and two are *Ppbb* (Fig. 5, squares numbered 6, 8, and 14). The former is pure for the polled factor, having received it from both parents; the others, however, have received it from one parent only, and are consequently impure. The polled character is already fixed in one-third of the red polled F2 beasts, but how are the fixed to be distinguished from the unfixed beasts? As pointed out in the previous article, this can be done by crossing with the recessive, which in this case is the horned beast. The fixed polled red *PPbb* gives only polled beasts when mated with horned animals, the impure polled red *Ppbb* gives on the average equal numbers of polled and horned. The above example was selected as a very simple illustration of the manner in which the "break-up" of the type, and the recombination of characters is interpreted on Mendelian lines, but the general principle applies to far more complicated cases. It has provided us with a simple explanation of the curious phenomenon of reversion on crossing, a phenomenon which has puzzled the practical breeder and the man of science. As, however, no fresh principle is involved in such cases there is no need to consider them here in further detail.

Many of the characters of animals with which the breeder deals, owe their manifestation to the presence of one or other definite factor, which is transmitted according to a definite scheme. If these factors are not divisible under normal conditions, they must be handed on through the germ cells as definite entities producing their full effect in each successive generation. Continual crossing of black with red does not diminish the potency of the black factor. So long as it is passed on through a germ cell it produces its full effect. This relative permanence of the factors, assuming it to be well founded, is doubly important

for the animal breeder. It assures him that a character put into a cross can be recovered from it by suitable procedure, even though it may for a time appear to be submerged and lost. It also offers the prospect of understanding, and so of controlling fully the material with which he works; but in order that he may be in a position to do this he must first be provided with an analysis of that material in terms of factors. The factor is for the breeder much what the atom is for the chemist. Though they may have a real existence, in practice both the atom and the factor are used as symbols. The chemist analyses his material in terms of atoms that he has never seen, but the conception of their existence is justified by the control he obtains when using the atomic theory as his guide. The theory guides the analysis that enables him to build up a conception of the chemical constitution of the substance he examines, and this conception enables him to predict the behaviour of the substance in its various reactions. Understanding the atomic nature of the substance, he can thenceforth control it; so also, the biologist is attempting to analyse his material in terms of factors which he has never seen. For if factors are something definite and permanent, following a definite scheme of distribution in heredity, it is clear that the characters of living things can be brought under accurate control by the breeder. They can be dissociated and recombined, just as the chemist dissociates and recombines atoms to make new substances.

This work of analysing the living beast is only beginning. It is only within recent years that the factorial theory of heredity was enunciated, and the scientific man is still busy testing how far it is sound. In simple cases such as those described above, it has certainly borne the test. The skipping of characters for a generation—the persistence of the unwanted recessive even in most highly pedigreed flocks and herds—the unfixable nature of certain types—the explanation of the curious phenomenon of reversion on crossing—the meaning of the break up of the type in the second generation from a cross—the principles governing the recombination of characters—all these things are now straightforward, and will be found treated of in a text book dealing with heredity. But can we interpret in terms of the factorial theory those cases, where at first sight there appears no suggestion of clear cut alternative pairs of characters—where a cross seems to result in a muddled blend—or must we confess that no solution has been found? It is such problems as these that have been engaging our attention at Cambridge for some years past, and a brief account of them will be given in the two following articles.

# REPORT OF THE BARBERRY AND THE BLACK RUST OF WHEAT SURVEY IN SOUTH WEST WALES.

W. H. Broadbent, A.R.C.Sc., D.I.C.

During the past two years several cases of the disease known as "black rust" of wheat, caused by the fungus *Puccinia graminis*, have been reported from South West Wales, and in view of the serious nature of this disease the Ministry of Agriculture and Fisheries, in conjunction with the Department of Agriculture of the University College of Wales, Aberystwyth, instituted investigations, the results of which are embodied in this report.

It is well authenticated that the common barberry (*Berberis vulgaris*) serves as spring host for the fungus which causes the black rust disease, and with the object of ascertaining the distribution of the common barberry and the extent of the occurrence of black rust a survey of the counties of Carmarthen, Cardigan and Pembroke was undertaken in the summer of 1920. Owing, however, to the many difficulties involved it has not yet been possible to complete the work.

**Methods employed in the Survey:—**

*Visits to Farms.*—As many farms as possible within a selected area were visited. The growing wheat and any straw lying about were carefully examined, and where evidence of disease was found search was made for barberry bushes. This method gave good results but took considerable time.

*Interviews.*—Few young or middle-aged persons appeared to know anything about the barberry bush, but it seemed to be familiar to the older people, especially women. Good and reliable information was readily furnished by elderly people in remote country districts. The help of schoolmasters in the rural districts was solicited, and in each case valuable assistance and information were obtained.

*Exhibitions of Specimens.*—Specimens of the common barberry and the black rust of wheat have been exhibited, particularly at the United Counties Agricultural Show, Carmarthen, in July, 1920. By this means interest was aroused amongst farmers which resulted in the location of a number of barberry bushes.

*Personal Search.*—Personal search, independent of outside help, was also made. The growth, colour and form of the barberry are characteristic, so that while travelling along country

roads it was possible, after a little experience, by glancing round the hedgerows to " spot " bushes growing in the vicinity. This method also yielded good results.

The survey extended over a period of three and a half months (May-August, 1920), but, when the hilly nature of the country and the difficulty of travel are considered, it will be readily understood that in this short period it was not possible to investigate more than one-third of the entire area.

**Description of the Bush.**—The common barberry (*Berberis vulgaris*), known in Welsh as *pren melyn*, or *pren clefyd melyn*, is said to be a native of Asia. It was introduced into Europe during the fifteenth century and cultivated as a " fruit " bush for several hundred years, until it was found to spread the rust " seeds." The berries were used in the preparation of preserves and jellies, and their juice for making wine and vinegar. When allowed to grow wild it is a tall erect shrub, often as many as 10 or 12 ft. high, and it is a persistent grower. The branches " are arched and hanging at the ends." The bark is greyish in colour and the wood is yellow. The branches bear three-parted spines at the base of the tufts of leaves (Fig. A). The leaves on the young shoots are alternate and green or purple in colour, but on the old shoots they occur in clusters. They are egg-shaped, rather stiff, and have saw-tooth edges (Fig. C). The berries are small, red, oval, and contain one or two seeds (Fig. B). The bark has been largely used for making a concoction which, the old people say, is an infallible cure for yellow jaundice (*clefyd melyn*) and for various diseases of cattle. It is not now, however, included in the British Pharmacopœia and is not used by dispensing chemists as it is not proved of value in these diseases, and its place as a bitter tonic has been taken by a number of drugs, such as gentian, quassia, dandelion or quinine.

**Occurrence of Barberry.**—Although the survey is incomplete, enough has been done to show that the bush is widely distributed in the three counties. In Carmarthenshire, 100 farms were visited and barberry was found to exist on 60 of them. It occurred chiefly round the homesteads and in the hedges about the farms. In all there were discovered 55 single bushes and 144 yd. of barberry hedge, the latter occurring in strips from 6 to 40 yd. in length. Each strip of barberry hedge, or even a single bush, may be the centre of a local outbreak of the disease, and 64 of these possible centres extending over 24 parishes, were located in this county. In South Cardiganshire, 40 farms were visited and barberry was seen on 30 of them. In all there

were found 25 bushes, and 68 yd. of barberry hedge—30 possible centres of infection, extending over 12 parishes. Pembrokeshire has not been systematically worked, but barberry is known to exist in 14 parishes. At one place there is a stretch of barberry hedge over 100 yd. long, and at another about 70 yd. long. These were the largest stretches met with, and it is a long time since wheat was grown near them. It is clear that if the survey were continued a very great deal more barberry would be discovered.

**Extent of Black Rust on Wheat.**—Time would not allow of justice being done to this part of the work, and in many places where barberry was found it was impossible to examine the wheat growing in the neighbourhood. However, 45 cases were observed in Carmarthenshire, 15 in South Cardiganshire and 14 in Pembrokeshire. In each of these cases, moreover, barberry was found in the immediate vicinity. From conversations with farmers there can be no doubt that the disease has long been prevalent over the greater part of the three counties.

**Results of Personal Interviews.**—It has been said that the farmers of a generation ago were aware that the common barberry caused the black rust of wheat. This, however, cannot be said of the present-day farmer in the surveyed district. To him the life-cycle of the fungus is a mystery and the disease is known to most of the farmers under the name of "blast"* and is regarded, as are most other diseases, as entirely due to wet weather. This idea is very deep rooted, and the fact that the life-history of *Puccinia graminis* seemed to many like a fairy tale, made it very difficult to convince them as to the true nature of the disease. Consequently, the way in which the information and advice given was received by the farmers depended chiefly upon the educational attainments of each individual, the quantity and position of the barberry and the condition of the wheat. Very few farmers, who had the black rust affecting their wheat, acted upon the advice given and removed the barberry at once, but every farmer who had barberry on his land admitted that he could never obtain a good crop of wheat when it was grown near the bush. The popular variety of wheat is "Hen Gymro" (Old Welshman) which is particularly susceptible to the black rust.

* Local terminology in respect to plant diseases is very indefinite and confused. "Blast" is applied to all rust diseases of cereals; "blight" and "blast" to the *Phytophthora* disease of potatoes and "blight" to Woolly Aphis on apple trees. The term "duon" (blacks) is also used in South Wales to designate black diseases of cereals such as rust, but more especially smut, while in North Wales bunt and smut are both known as *penddu* (blackhead).

**Field Observations on the Disease.—**

*Spring Stage.*—The disease appears on the under surface of the leaves of the common barberry in the form of yellow or orange-coloured swollen patches (Fig. A). These patches vary in size and may be as much as half an inch in diameter, and when examined by the aid of a hand lens are seen to consist of numerous cups known as "cluster cups." During the year 1920 the cluster cups were first observed on the barberry in Pembrokeshire on the 8th May, and from that date they were seen continuously until the end of August. On reaching maturity a few weeks after the appearance of the spot the cluster cups open and the contents (a very fine yellow powder) are easily distributed by the wind. This powder consists of the spores* or "seeds" of the fungus, which when blown on to wheat produce, if conditions are favourable, the summer or "red" rust stage.

*Summer Stage.*—The summer stage generally appears on the wheat leaves and stems in the form of reddish-brown, elongated spots, which give the wheat a rusty appearance. From its abundance on the stems the disease is termed in America the black *stem*-rust. These spots consist of masses of "summer spores"† which help to spread the disease during summer. The first outbreak of the disease for the year 1920 was noted on the 27th July on autumn sown wheat in Pembrokeshire. The second case was found in Cardiganshire on the 28th July; it was a bad attack, and apparently the disease had commenced much earlier than the date of the visit. This view was confirmed by the farmer, who stated that he had noticed the disease about the first or second week in July. The summer-spore stage was also seen on spring wheat "April Bearded" as late as the 13th September. The time of appearance of the disease in all probability depends on (1) climatic conditions, (2) proximity of barberry, and (3) state of maturity of the wheat.

*The Winter or Black Stage.*—A winter stage gradually displaces the red summer stage. It appears on the surface of the stem in the form of conspicuous black streaks, which consist of the resting spores‡ of the fungus (Fig. D). During the year 1920 this stage was observed as early as the 27th July, the same date as the red stage, and it was here noted that the transition from the red summer stage to the black stage had taken place comparatively quickly, probably within a fortnight's time. In other

* The spores from the cluster cups or *aecidia* on barberry are called aecidiospores.

† The Summer spores on the wheat are termed uredospores.

‡ The resting spores produced from the black stage on the wheat are termed teleutospores.


THE COMMON BARBERRY (*Berberis vulgaris*).

A.—Flowering Shoot in May or June, showing the Cluster Cup stage of the Rust Fungus forming yellow or orange coloured spots on the leaves. The spines on the stems, usually in threes, distinguish this from most common, garden Barberries.

B.—A Shoot in Autumn, with long red Berries which hang in clusters.

C.—Leaves, enlarged, showing tooth margins and the yellow spots with the Cluster Cup stage of the Fungus. The spores from these cups infect the Wheat.

D.—A small piece of Wheat attacked by Black Rust showing as black lines on the stem.

cases (see below) the change took place more gradually. The black resting spores remain dormant on the straw and stubble through the winter, germinate in the spring and give rise to other minute spores, which infect the barberry leaves, thus completing the life-cycle of the fungus.

A small point, though possibly of great practical importance, was observed in connection with the summer spores. It was noted that in some varieties of wheat these spores (the uredospores) did not break through the epidermis of the stem. The red stage was visible within the stem but it never burst through, merely slowly changing to the black or teleutospore stage. Late in the season, when the transition from one stage to the other was complete, the epidermis was ruptured and the black winter-spores were exposed for dispersal. This might have been an unusual occurrence due to the low temperature prevailing through the summer. However, the matter calls for further investigation, because, if varieties of wheat can be found in which the uredospores are not exposed for dispersal, such varieties will not spread the summer stage. Further, the rupturing of the epidermis injures the wheat owing to the loss of water by evaporation, and if this does not take place in some varieties until late in the season these should give better yields than those in which the epidermis is broken early. In short, varieties of wheat in which the uredospore stage does not break through, the epidermis may be regarded as partial "resisters."

**Spread of Disease from Barberry to Wheat.**—The spread of the disease from barberry to wheat was observed fairly closely at two places. In one case, there were two barberry bushes in the middle of a hedge alongside the wheat, and in the other there was a strip of barberry hedge, eight yards long, near one corner of the wheat field. In both cases it was obvious that the disease had commenced, and that the intensity was greater, near the barberry. To one of these places two farmers were taken to witness this for themselves, and after going carefully over the field they were fully satisfied that the barberry was a contributing factor in disseminating the disease.

**Effect of Black Rust on Wheat Growing in South West Wales.**—Although this part of Wales is mountainous and not considered generally suitable for wheat growing, there are districts where wheat might be more successfully grown if it were not for the presence of the barberry and the black rust disease. Most of the farmers endeavour to grow enough for home consumption, and many would sow more wheat if they

could grow a profitable crop. The conditions are clearly least favourable within "Barberry Areas." Some of the farmers have tried wheat-growing so often, with such disappointing results, that they have given up the practice altogether. In face of this evidence, one is forced to the conclusion that the barberry is directly responsible not only for a considerable reduction in yield per acre but also in the amount of wheat grown, and that if this factor were eliminated the yield and acreage would appreciably increase.

It may further be noted that in 1920 the Ministry of Agriculture made a special effort to ascertain all cases of black rust in the country. England as a whole was found to be remarkably free from the disease, and the common barberry is scarce. A few quite small outbreaks were located, the worst case, in Gloucestershire, being in immediate proximity to badly rusted barberry in a hedge. Many farms in parts of Devonshire and Cornwall (which counties have a similar climate to South West Wales) were examined and no case of black rust was observed, and during the inspection hardly a single bush of the common barberry was met with.

**Losses caused by Black Rust.**—In order to give some idea of the damage caused by this disease, the losses suffered by a farmer in Cardiganshire during the last two years might be quoted. On this particular farm there was, until recently, a strip of barberry hedge ten yards long. In 1919 wheat was grown alongside this hedge and the intensity of the disease was so great that the crop only yielded eight bushels per acre, and the straw was of little value. During 1920 wheat was again grown near the barberry, but on advice the latter was cut down on the 20th May. This date was, unfortunately, rather too late, as cluster cups were present on the barberry and some of the spring spores had already been dispersed. The disease made its appearance in July. Before the crop was cut it was noticed that the intensity of the disease was much less than in 1919, and on being threshed the crop yielded sixteen bushels per acre, and the straw was much better. This decrease in the severity of the attack might have been partly due to the cold, wet summer, but there is reason to believe that the cutting down of the barberry also helped. In any case, the farmer was quite pleased with the result, and will dig up the entire plants with roots before next spring. From this example it will be seen that the losses caused by the disease may be very high, and in years of epidemics the crop

may be practically a total loss. The statistics for the year 1919 give the area under wheat in the counties of Carmarthen, Cardigan and Pembroke as 22,000 acres, and much of this wheat land must fall within the range of influence of the barberry, so that the loss directly attributable to the latter is in the aggregate very considerable, even assuming that the existence of the barberry is not, as many now believe, an absolutely essential condition for the existence of the disease on wheat.

## Summary.

1. It is ascertained by means of the survey that the common barberry is widely and plentifully distributed in Carmarthenshire, Pembrokeshire and South Cardiganshire. The cluster-cup stage of the black rust fungus is abundant on the barberry in spring and early summer.

2. On the wheat black rust may be said to be generally distributed over the same area, and causes serious losses every year. In certain seasons the attacks are very severe.

3. Wheat is regarded as a risky crop in these counties, and is certainly not a paying one in barberry areas. As a result there is a reduced acreage under wheat, and this is diminishing.

4. The common barberry is the alternate host of black rust, giving the fungus a good start each spring. In several concrete cases field-observations showed that the disease was most intense near the bushes and had started from them. As long as barberry is allowed to remain it will be a constant source of infection, not only to the adjacent wheat fields, but to other fields on which the summer spores from the wheat will be blown.

5. In more than one case, the removal of barberry bushes resulted in slighter attacks on adjoining fields than in the previous season, but until barberries are eradicated on a wholesale scale no complete elimination of the disease can be expected, owing to spores blowing from other fields. Every bush destroyed means so many less initial infections and the fewer the infections the better will be the wheat crop.

6. Black rust is very scarce in all other parts of the British Isles and there appears no reason to doubt that if the barberry were exterminated in Wales the annual attack of black rust on wheat would subside. This method was adopted in Denmark eighteen years ago, and black rust in that country has now practically ceased to exist.

# POLLINATION OF FRUITS.

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IN choosing land for fruit planting, there are several factors to be considered, such as distance from market, climate, aspect, and protection from frost by careful selection of site. The next point is the kind of fruit to be planted, after which comes the choice of varieties suitable for the district. The prospective planter is advised to limit the number of varieties he plants to, say, six varieties of each kind of fruit tree grown, in order to be able to send considerable quantities of each variety to market.

Growers have sometimes planted a single variety alone by the acre (for example, Lane's Prince Albert Apple, Pitmaston Duchess Pear, River's Early Prolific Plum, or Early River's Cherry), with the result that, although it has grown strongly and flowered profusely, it does not fruit satisfactorily. The reason for this is that, in Nature, each apple, pear, plum or cherry tree springs from a separate seed; each tree is a distinct individual. The nurseryman or fruit grower compares the fruit of the different trees and selects those which produce the best fruit. Experience has taught him that the majority of trees grown from seed are not quite like their parents: in most cases their fruits are inferior to those of the parent. He therefore takes shoots of the selected tree and propagates the variety by grafting or budding on suitable stocks. Now each of these trees is part of the original tree: each bears similar fruit and has similar habits.

Nature in general favours cross-pollination for the production of good-sized fruit and seed of vigorous growth, but in the case under consideration each tree is similar, being of the same origin and not grown fresh from seed according to Nature's plan. Pollination by the same variety is, therefore, a form of self-pollination, and does not give the best result in the majority of cases.

Practical botanists in England, America and Australia, who have made experiments on the fruiting of the apple, pear, plum and cherry, find that relatively few varieties are strongly self-fruitful. Of apples, less than one-half of the varieties appear to be self-fruitful; of pears, about one-half; of plums, about

two-thirds; and of cherries, not more than one-third, when grown in the open air; but under the more favourable conditions of glass-house culture a larger proportion of varieties mature fruit with their own pollen.

The best system of planting, as indicated by observation, is to intermix varieties to a certain extent. Thus, for an orchard two or three varieties having somewhat the same blossoming period should be chosen. In other words, the grower should avoid planting varieties that flower very early with those that flower very late. It is also preferable to plant lines of trees with a different variety—*e.g.*, Cox's Orange Pippin and Worcester Pearmain—in alternate rows. In cases where a whole orchard or a large block has been planted with one variety, such as Amber Bigarreau cherry, every fifth tree or so may be regrafted or replanted with another variety, choosing, perhaps, Frogmore Bigarreau, the two varieties being found to cross-pollinate well. In the case of cherries, it is found that not all varieties are inter-fertile, and it may be advisable, therefore, to plant three different varieties in an orchard.

**Pollenizing Agents.**—Nature's pollenizing agents are chiefly the wind and insects. In the case of *walnuts* and *cob nuts*, the wind carries the light pollen from the catkins to the nut blossoms. In the case of gooseberries and black and red currants, the pollen of which is glutinous, it is necessary for insects to transfer the pollen from flower to flower, for the wind is unable to carry it. In the case of apples, pears, plums and cherries, very little pollination appears to be due to the wind. Hive bees, bumble bees and other wild bees appear to be the insects best adapted for carrying the pollen.

**Experiments on the Pollination of Fruits.**—From trials in America, Australia, at the Royal Horticultural Society's Gardens at Wisley, and at the John Innes Horticultural Institution at Merton, observations have been made as to the movement of pollen by the wind. The effect of placing muslin around fruit trees in order to exclude insects was also investigated, and it was found that trees so enclosed produced either no fruits or very few fruits, whereas similar trees in the open produced hundreds of fruits; which showed that wind did not help much and that insects were necessary.

In the writer's own trials, *strawberries* under muslin which allowed a certain amount of air movement but excluded insects matured good fruit, the weather being sunny. With strawberries in pots under glass, more perfect and larger fruits

matured on plants that were hand-pollinated, than on the plants, the pollen of which was only transferred by the draft due to the ventilation of the house.

*Raspberries and loganberries*, enclosed in bags during blossoming but not hand-pollinated, did not mature as well as bushes in the open.

*Gooseberries, black, red, and white currants* matured hardly any fruit, but where they were hand-pollinated all matured fruit plentifully.

The following table gives a summary of the general results of the writer's trials with fruit tree blossoms made between 1911 and 1920: (1) Excluding insects; (2) Hand pollinating with pollen of its own variety by means of brush or forceps; (3) Hand pollinating with pollen of other varieties.

| | Number of varieties experimented with. | 1 | | | 2 | | | 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Insects excluded. | | | Self-Pollinated. | | | Cross-Pollinated. | | |
| | | No. of bags used. | No. of fruits set. | No. of fruits matured | No. of bags used. | No. of fruits set. | No. of fruits matured | No. of bags used. | No. of fruits set. | No. of fruits matured |
| Apple | 108 | 540 | 330 | 36 | 252 | 288 | 71 | 323 | 640 | 231 |
| Pear | 38 | 115 | 163 | 27 | 73 | 56 | 18 | 97 | 165 | 63 |
| Plum | 27 | 71 | 170 | 75 | 51 | 250 | 93 | 98 | 269 | 147 |
| Cherry | 18 | 62 | 53 | 16 | 52 | 141 | 62 | 93 | 323 | 199 |
| Peach | 4 | 1 | 1 | 0 | 2 | 2 | 2 | 5 | 8 | 6 |
| | | 789 | 717 | 154 | 430 | 737 | 246 | 616 | 1,405 | 646 |

On an average five flower buds were enclosed in each bag, but a slightly larger number in the case of cherries. The camel hair brush used for pollinating was sterilised after use by dipping in methylated spirit. There were several handicaps to the experiments, some of which were:— (1) Risk of destruction by insect attack (aphis, psylla, caterpillars hatching out in bag); (2) Risk of destruction by fungus attack (Brown rot disease); and (3) Risk of missing the most favourable time for pollination. Although a larger number of trials in each kind of fruit would have given more accurate information, the results obtained give some data regarding fruit pollination. For instance, in the case of apples, twice as many fruits matured when a variety was pollinated with its own pollen as when left with insects excluded, while three times as many matured with cross-pollination as when flowers were pollinated with their own pollen.

Judging from the opinion of investigators in America, and from the writer's own observations extending over several years

in this country, it would seem that hive bees, bumble bees and the smaller wild bees take the greatest part in cross-pollination. By reason of their habits they are better able to act as carriers of pollen than other insect visitors are, and the operation is further assisted by their hair-covered bodies and legs. Bumble bees work earlier and later as well as in less favourable weather than do hive bees. Again, where there are extensive fruit plantations the number of wild bees is small compared with the number of flowers that should be visited. It is, therefore, of great advantage to keep hive bees near fruit plantations. This is especially the case with cherry orchards, especially in seasons when the weather is unfavourable for the fertilization of the blossoms: the bees are then at hand to cross-pollinate the blossoms during the short intervals suitable for that work. In 1920 the weather was cold, rainy and windy during most of the blossoming time of cherries, yet it is believed that where bees were kept the crop of cherries was much better than where bees were not kept. One orchard was seen which usually produced several tons of cherries, but which in 1920 only produced a peck. No bees were kept in the neighbourhood. Another orchard where bees were kept, produced a good crop.

Hives of bees are probably best placed within a few hundred yards of the fruit plantation. If, as is likely, the fruit grower is too busy to look after the bees himself, it would repay him well to offer a bee keeper free standing room for his hives, or even to pay him a few shillings for each hive placed near the orchard, the bee keeper looking after them and keeping the honey.

In cherries, apparently the only thoroughly self-fruitful variety is the Morello. All other varieties benefit by pollination with pollen of another variety.

Among plums, Pershore Yellow Egg and Pershore Purple Egg and some damsons and bullaces are very self-fertile and can be planted alone. Next, perhaps, come Victoria, Monarch, Czar, Denniston's Superb, but all these crop better when interplanted with other varieties.

In the case of apples and pears, no variety can be recommended to be planted alone in quantity.

**Object and Procedure of the Trials.** The object of these experiments was to elicit information on three points:—(1) The effect of excluding insects; (2) Whether the variety matured fruit with its own pollen; and (3) Whether the variety set fruit better with pollen of a different variety.

With regard to the method, paper bags (as used by confectioners for sweets) and muslin bags were employed. The bags were tied over the unopened flower buds shortly before their opening.

About five flower buds each of apple, pear or plum, and ten of cherry were enclosed, and were left untouched until the petals had fallen, when the fruits set were counted and noted.

The bags were removed when the flowers opened, and pollen taken from the same flower (the same tree or another tree of the same variety), was applied with a camel hair brush to the stigmas; in some cases stamens containing pollen were used with forceps for applying the pollen, and after the petals had fallen, the bags were taken off and the number of young fruits counted.

When the flowers had opened, the bags were removed, and pollen taken from a different variety was applied to the stigmas, after which the bags were tied up again.

Emasculation is advisable in the case of self-fertile varieties; when buds are emasculated, the stamens of the flowers are removed by scissors, forceps or a fine comb before the pollen has shed; foreign pollen was usually applied at the same time. The bags were afterwards replaced and left on till the petals had fallen, when the young fruits were counted. During the trials, observations were made and notes were taken in each case about once a fortnight until the fruit was mature and nearly ready to pick.

## Pear Trials (1911-20).

The results from the following varieties of pears were :—

| VARIETIES. | LEFT. | | | OWN POLLEN. | | | FOREIGN POLLEN. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. |
| Conference ... ... ... ... | 25 | 49 | 7 | 13 | 27 | 6 | 13 | 48 | 7 |
| Durondeau ... ... ... ... | 13 | 52 | 10 | 4 | ? | 4 | 4 | ? | 11 |
| Williams' Bon Chrêtien ... ... | 10 | 9 | 1 | 5 | 8 | 0 | 19 | 39 | 15 |
| Dr. Jules Guyot ... ... ... | 9 | 4 | 0 | 3 | 1 | 1 | 5 | 14 | 9 |
| Beurré Hardy ... ... ... | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 |
| Doyenné du comice ... ... ... | 5 | 1 | 1 | 2 | 1 | 1 | 10 | 6 | 1 |

Other varieties that showed themselves more or less self-fruitful were :—Triompe de Vienne, Petite Marguerite, Colmar d'Eté, Doyenné d'Eté, Marguerite Marillat, Duchesse d'Angoulême, and Pitmaston Duchess.

Pears that failed to mature fruit with their own pollen include:—Beurré Rance, Catillac, Clapp's Favourite, Emile d'Heyst, Fertility, General Todleben, Josephine de Malines, Le Lectier, Marie Louise, Nouvelle Fulvie, Passe Cresanne, and Uvedale's St. Germain. Twelve varieties of pear matured fruit with their own pollen out of 38 varieties tried.

## Cherries.

Varieties that proved self-fruitful in these trials:—

| CHERRIES more or less SELF-FRUITFUL. | LEFT. | | | OWN POLLEN. | | | FOREIGN POLLEN. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Bags. | Number of Fruits Set. | Number of Fruits matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. |
| Wye Morello : (Perfectly self-fertile) | 3 | ? | 10 | 4 | ? | 17 | 2 | ? | 2 |
| Morello : (Very self-fertile) ... | 5 | 9 | 2 | 10 | 13 | 26 | 3 | 13 | 10 |
| Roundels ... ... ... ... | 2 | 10 | 0 | 2 | 17 | 6 | 3 | 14 | 8 |
| Turk .. ... ... ... ... | 6 | 8 | 1 | 6 | 9 | 6 | 5 | 32 | 18 |
| Circassian ... ... ... ... | 2 | 0 | 1 | — | — | — | 2 | 12 | 10 |
| Elton Heart ... ... ... ... | 7 | ? | 2 | 6 | 26 | 4 | 13 | 60 | 42 |
| Napoleon Bigarreau ... ... | 4 | 13 | 0 | 5 | 25 | 3 | 6 | 37 | 8 |

In addition to these, it was found at Merton that Flemish Red and Late Duke were self-fertile, and Mayduke and Archduke partly self-fertile. The following varieties of cherries failed to mature fruit with their own pollen :—

| CHERRIES SELF-STERILE (in these trials). | LEFT. | | | OWN POLLEN. | | | FOREIGN POLLEN. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. |
| Early Rivers : (9 pollens tried, good fruit matured with pollens of Old Kentish Black, Elton, Waterloo, Amber Bigarreau, Black Eagle, Florence and Turk) ... ... | 8 | 2 | 0 | 4 | 5 | 0 | 15 | 89 | 60 |
| Amber Bigarreau : (8 pollens tried ; fruit matured with Turk, Frogmore, Napoleon and Old Black Heart pollens) ... ... ... | 1 | 0 | 0 | 3 | 0 | 0 | 11 | 24 | 16 |
| Frogmore Bigarreau : (5 pollens tried ; best results from Amber Bigarreau and Turk) ... ... | 3 | 10 | 0 | 3 | 16 | 0 | 5 | 25 | 18 |
| Black Eagle : (Fruit matured with pollen of Knight's Early Black)... | 4 | 0 | 0 | 2 | 0 | 0 | 5 | 7 | 4 |

The following also failed to mature fruit in these trials with their own pollen:—Kentish Preserving, Knight's Early Black, Old Kentish Black, Waterloo; and at Merton:—Black Tartarian, Bigarreau de Schreken, Bigarreau Noir de Guben, Bigarreau Jaboulay, Governor Wood, Guigne d'Annonay, and White Heart.

Trials in the pollination of cherries seem to be of special importance, as so many are self-sterile, and some varieties are inter-sterile, or nearly so. Cherries need patient and numerous trials extending over several seasons, for results of one year do not absolutely tally with those of another year. Season, position of trials on tree, health or constitution of the tree, disease, insects, accidents, frosts—all these influence results and make trials advisable on different trees, in different orchards and in different localities. Although the result of individual trials may vary somewhat with the order of blossoming, yet the general results are the same year by year, showing the advisability of inter-planting varieties for cross-pollination and demonstrating the value of hive and wild bees in carrying pollen from flower to flower.

**Apple Trials (1911-1920) : Self-fruitful Varieties.**

| APPLES more or less SELF-FRUITFUL. | LEFT. | | | OWN POLLEN. | | | FOREIGN POLLEN. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. |
| The following are given as examples:— | | | | | | | | | |
| Lord Derby: (With own pollen it matured as large fruit as average, some being among largest on tree; matured fruit with pollen of Grenadier, Charles Ross and Bismarck) ... ... ... ... | 7 | 15 | 4 | 17 | 46 | 11 | 8 | 11 | 5 |
| Irish Peach: (Fruit from "Left" and "Self-pollinated" as good as average) ... ... ... ... | 19 | 49 | 5 | 17 | 58 | 16 | 3 | 11 | 6 |
| Newton Wonder: (Good fruit matured with own pollen; from 9 cross-pollinations fruit only matured with pollen of Lord Derby) ... ... .. ... | 17 | 4 | 1 | 4 | 8 | 5 | 11 | 38 | 3 |
| Worcester Pearmain: (7 foreign pollens tried; best results with Cox's Orange, Allington, Beauty of Bath and King of the Pippins) | 14 | 4 | 0 | 9 | 7 | 2 | 26 | 46 | 23 |

Space will not permit of further details, but the following additional varieties proved more or less self-fruitful in these

trials:—Potts' Seedling, Summer Golden Pippin, Christmas Pearmain, Baumann's Red Winter Reinette, Crawley Beauty, Miller's Seedling, Brownlee's Russett, John Downie Crab, James Grieve, Ecklinville Seedling, Ellison's Orange, Charles Ross, Golden Spire, Early Red Victoria, Baldwin, Ben's Red, White Transparent, Peasgood's Nonsuch, Adam's Pearmain, Rival, Striped Beaufin, Washington, King of the Pippins, Bismarck, Ribston Pippin, Rambleur Pepelin, Egremont Russet, Warner's King, American Mother. Other varieties found self-fertile elsewhere include Stirling Castle, Keswick Codlin, Devonshire Quarrenden, Cellini, Coronation, and Duchess of Oldenburgh.

The following apples failed to mature fruit in these trials when "left" or when pollinated with their own pollen:—

| APPLES that appear to be SELF-STERILE (or very nearly so). | LEFT. | | | OWN POLLEN. | | | FOREIGN POLLEN. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. |
| Typical examples:— | | | | | | | | | |
| Lane's Prince Albert: (No attempt to set fruit with own pollen; matured fruit with pollen of the Queen and Bramley) ... ... ... ... | 10 | 0 | 0 | 7 | 0 | 0 | 8 | 8 | 4 |
| Grenadier ... ... ... ... | 9 | 1 | 0 | 3 | 0 | 0 | 8 | 16 | 4 |
| Beauty of Bath; (4 pollens tried; good fruits matured with pollens of Cox's Orange and Summer Golden Pippin) ... ... ... | 8 | 3 | 0 | 2 | 5 | 0 | 5 | 8 | 2 |
| Bramley's Seedling ... ... ... | 19 | 2 | 0 | 12 | 0 | 0 | 12 | 15 | 7 |
| Cox's Orange Pippin: (22 pollens tried; best results from Worcester Pearmain, John Downie Crab, Allington, Bramley, Grenadier, High Canons, Beauty of Bath, Cleopatra, Ribston, and Bismarck; 9 varieties failed, including Lane's Prince Albert) ... ... | 45 | 0 | 0 | 2 | 2 | 0 | 56 | 108 | 36 |
| Allington Pippin: (7 pollens tried; Ribston and Worcester Pearmain produced good fruits and Summer Golden Pippin the finest fruit on the tree) ... ... ... ... | 22 | 3 | 0 | 3 | 0 | 0 | 11 | 17 | 7 |

Other varieties that failed to mature fruit with their own pollen included:—Alfriston, Annie Elizabeth, Barnack Beauty, Beauty of Kent, Belle de Pontoise, Benoni, Blenheim Orange, Brabant Bellefleur, British Columbia, Byford Wonder, Claygate Pearmain, Cleopatra, Cockle Pippin, Court Pendu-plat, Crimson

Bramley, Cox's Pomona, Duchess Favourite, Duke of York, Foster's Seedling, Gladstone, Hamling's Seedling, Hector Macdonald, High Canons, Hoary Morning, Hormead's Pearmain, Hunt's Early, King's Acre Pippin, Lady Henniker, Mère de Ménage, May Queen, Norfolk Beauty, Rome Beauty, Sandringham, Sanspariel, Seaton House, Striped Beaufin, Sturmer Pippin, The Queen (Saltmarsh's), Wagener, Waltham Abbey, Wealthy, Wellington.

In the trials at Wisley and Merton the following varieties were found somewhat self-fruitful:—Bramley's Seedling, Crimson Bramley, Allington, Sturmer, and Annie Elizabeth; in the case of Cox's Orange Pippin only four fruits matured in 61 trials, which shows that this variety is very rarely self-fertile.

## Plum Trials (1911-20).

The following showed themselves self-fruitful:—

| SELF-FRUITFUL PLUMS. | LEFT. | | | OWN POLLEN. | | | FOREIGN POLLEN. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. | Number of Bags. | Number of Fruits Set. | Number of Fruits Matured. |
| Pershore Yellow Egg: (Perfectly self-fertile) ... ... ... | — | — | — | 3 | 36 | 15 | 1 | 13 | 4 |
| Pershore Purple Egg: (Perfectly self-fertile) ... ... ... | 10 | 47 | 24 | 5 | 36 | 15 | 7 | 26 | 11 |
| Victoria ... ... ... ... | 8 | 21 | 18 | 3 | 14 | 7 | 8 | 15 | 12 |
| Czar ... ... ... ... ... | 9 | 46 | 24 | 8 | 42 | 11 | 5 | 37 | 14 |
| Denniston's Superb ... ... ... | 6 | 19 | 4 | 7 | 37 | 15 | 2 | 9 | 9 |
| Monarch ... ... ... ... | 3 | 6 | 0 | 3 | 16 | 4 | 3 | 13 | 1 |

Other varieties that showed themselves more or less self-fruitful were:—Damson (? Farleigh), Bradley's King of Damsons, Bullace (yellow with orange streaks), Bittern, Rivers' Early Prolific. At Merton the following additional plums were found self-fertile:—Early Transparent, Early Mirabelle, Golden Transparent, Gisborne (each very self-fertile), Reine Claude Violette, Reine Claude de Bavay, Oullins Golden Gage, Belle de Louvain, Prince Englebert, Giant Prune, Yellow Magnum Bonum, Myrobalan, Red and Belgian Purple; the following were classified as partly self-fertile:—Early Orleans, Early Favourite, and Cox's Emperor. Rivers' Early Prolific, which, with its own pollen, matured only one fruit to about 100 flowers.

The following plums failed to mature fruit with their own pollen :—Admiral, Black Diamond, Coe's Golden Drop, Golden Gage, Jefferson, July Greengage, Old Greengage, Pond's Seedling, and President. At Merton, the additional varieties that showed themselves self-sterile were :—Coe's Violet, Crimson Drop, McLaughlin's Gage, Early Greengage, Reine Claude d'Althann, Wyedale, Frogmore Orleans, Late Orleans, Prune d'Agen, Primate, and Frogmore Damson.

In certain varieties of plum, cherry, and, perhaps apple and pear, it is advisable, in order to obtain the largest quantity of the best fruit, to ascertain whether they cross-pollinate each other well, in addition to planting together varieties that flower at the same time.

In trials with four varieties of outdoor peaches, each appeared to be self-fertile, but fruiting was increased by hand pollinating with a camel-hair brush.

# DRY SPRAYING FOR THE DESTRUCTION OF CHARLOCK.

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ONE of the most successful operations now commonly carried out in farming practice is admittedly that of the destruction of Charlock in corn crops by means of a spray, consisting generally in this country of a 4 to 5 per cent. solution of sulphate of copper (Bluestone), that is to say 4 to 5 lb. of sulphate of copper to 10 gal. of water, applied at the rate of 40 to 60 gal. per acre.

In certain parts of the country, however, where the shortage of water is at all times a serious problem for the farmer, wet spraying, if not a matter of impossibility, is at least one which makes too great a demand on the limited water supply, or entails more labour in carting water to outlying parts of the farm than can be conveniently or economically spared. In such districts, a considerable advantage would be gained if it were possible to substitute a dry powder for the wet spray, provided the former was equally efficacious, and not unreasonably expensive.

It was with this object in view that the present experiments with dry sprays of some powdered chemical substances were arranged, and carried out during the last two years.

From published reports it was found that a certain amount of experimental work had already been done on the subject, and a short summary of this is given below.

## SUMMARY OF FORMER TRIALS OF DRY POWDER SPRAYS.

The substances tested, of which records have been found, were Calcium Cyanamide (Nitrolim), Sulphate of Iron, Nitrate of Lime, and Kainit.

**I. Calcium Cyanamide.***—The experiments recorded in references 1-5 are of German origin, except No. 3 which is Swiss; the quantity of calcium cyanamide applied varied from

*(1) *Jour. Board of Agric.*, Dec., 1907, p. 568.
(2) *Jour. Board of Agric.*, Dec., 1909, p. 761.
(3) *Jour. Board of Agric.*, Jan., 1909, p. 776.
(4) *Jour. Board of Agric.*, Oct., 1913, p. 618.
(5) *Jour. Board of Agric.*, April, 1914, p. 64.
(6) "Charlock Destruction," Bull. I, Agric. Dept., Univ. Coll. of N. Wales, Bangor.
(7) Die Verbreitung u. Bekämpfung der Ackerunkräuter in Deutschland, Bd. 1, May, 1918: *Arbeiten der D.L.G.*, Heft. 294.

60 to 240 lb. per acre, and its destructive effect on the Charlock was said to be generally satisfactory. In Ref. 7, however, a comparatively recent German book which summarises a large number of experiments on weed destruction, the author is much less sanguine as to the value of calcium cyanamide in this direction. In Ref. 6, calcium cyanamide is not recommended.

**II. Sulphate of Iron** (Ferrous sulphate).*—Ref. 8 refers to work of French origin; the quantity of sulphate of iron used varied from 3 to 4 cwt. per acre, and was stated to give satisfactory results, if applied before the flowering stage of the Charlock. In Ref. 7 given above, the common crystalline form of sulphate of iron is not strongly recommended, but a specially prepared anhydrous form of the salt is said to be efficacious. The latter substance, however, would be difficult to obtain, and would certainly be much dearer than the ordinary crystalline salt.

**III. Nitrate of Lime.**†—The only reference is to an experiment of German origin, and the results are not very satisfactory.

**IV. Kainit.**‡—The reference is to an experiment of German origin. The quantity recommended is not less than 1050 to 1250 lb. per acre.

The results appeared to be very satisfactory when moist conditions prevailed at the time of application. Ref. 7, however, states that success is only possible with a powdered kainit, which is a speciality of the German Potash Syndicate.

*Note.*—No records have been found of any trials made with powdered sulphate of copper.

## PRESENT EXPERIMENTS.

**Dry Spray Trials, 1919.**—These were carried out on Mr. Wilson's farm at Garforth, near Leeds. The substances selected for the test were Nitrolim, 'Sulphate of Iron,' and Sulphate of Copper (Bluestone). Each was obtained in as fine a powder as was possible, and, in the case of the first two substances, the state of fineness was very satisfactory. The copper sulphate was, however, a little coarse, having been partly sifted out and partly ground from the stock supply kept in the laboratory. Unfortunately fresh nitrolim could not be obtained at the

*(8) *Jour. Board of Agric.*, Dec., 1909, p. 761.
(9) *Jour. Board of Agric.*, June, 1911, p. 244.
†(10) *Jour. Board of Agric.*, April, 1911.
‡(11) *Jour. Board of Agric.*, Aug., 1914, p. 451.

time, and that used was several years old. The sulphate of iron, as is inevitable, was oxidised to some extent, but analysis showed it to contain 87 per cent. of the ferrous salt.

The field in which the experiment was conducted carried a crop of barley in which Charlock grew abundantly. The spraying was carried out on June 16th, 1919, and at this time the Charlock was in full flower, and a considerable amount of seed was set. The corn was, on an average, 9 in. high.

Six plots, each having an area of 1/40th acre, were marked out and treated as follows:—

| | *lb. applied per acre.* |
|---|---|
| 1. Nitrolim ... ... ... ... | 140 |
| 2. Untreated ... ... ... | — |
| 3. Sulphate of Copper ... ... | 45 |
| 4. „ „ „ ... ... | 100 |
| 5. Sulphate of Iron ... ... ... | 200 |
| 6. „ „ „ ... ... ... | 400 |

Dry, hot weather prevailed, and, in order to ensure that the powders should adhere to the plants, the spraying operations were carried out at 3 a.m., immediately before sunrise when the dew was on the leaves. The knapsack spraying machine used was Strawson's "Coronette." The day succeeding the spraying was fine, but rain fell 36 hours after the operation, and the weather then remained unsettled for two or three weeks.

*Results.*—The plots were first examined on June 20th, four days after spraying, and the following notes made:—

Plot 1. No obvious effect.
„ 2. Untreated.
„ 3. Leaves and flowers of the Charlock badly withered; seed pods still green, but unhealthy in appearance.
„ 4. Similar to Plot 3, but effect more marked.
„ 5. Leaves of Charlock withered, but flowers and seed pods not greatly affected.
„ 6. Similar to Plot 5.

Later examinations showed a quickly developing effect on Plots 3 and 4. On Plots 5 and 6 there was also further deterioration of the Charlock leaves, and the flowers were also affected, but the seed pods were only injured on the plot with the heavier dressing of sulphate of iron.

A final examination was made on July 9th, three weeks after spraying, and the following report made:—

Plot 1. No visible effect.
„ 2. Untreated.

Plot 3. On 75 per cent. of the Charlock plants, not only were the leaves and flowers dead, but the seed pods were so shrivelled, that the seed within them had scarcely developed at all.

On the remaining plants only the larger seed pods were living, and these appeared able to set seed. Thistles on the plot were badly damaged, and Coltsfoot slightly damaged.

„ 4. Practically all the Charlock had been destroyed, including even those plants bearing full grown seed pods. Thistles badly damaged; many being killed. Coltsfoot badly damaged, but not killed.

„ 5. The leaves and flowers of the plants were badly withered, but the seed pods were very little injured, and would apparently set seed. Thistles were uninjured, and Coltsfoot very slightly injured.

„ 6. The leaves and flowers of the plants were killed, and in about 30 per cent. of the plants the seed pods were also dead. Thistles and Coltsfoot slightly injured.

No lasting deleterious effect on the barley was observed on any of the plots.

It is evident from the foregoing that the best results were obtained with sulphate of copper, and, in the unbiassed opinion of the farmer on whose field the experiments were conducted, these plots were entirely successful. The sulphate of iron, especially in the heavier dressing, also destroyed the leaves and flowers of the Charlock plants, although its action was obviously slower than that of the sulphate of copper, and would thus be more liable to be checked in the case of rain falling soon after the application of the spray. The total failure of the nitrolim was thought to be due, possibly, to its having been kept for so long beforehand, exposed to the air.

The experiment was regarded as having fully demonstrated the possibility of using dry sprays for the eradication of Charlock, and it seemed probable that, by spraying earlier in the season, equally good results might be obtained with smaller quantities. In the case of sulphate of copper a still greater advantage would certainly be gained if the substance could be obtained in a finer state of division, since obviously the finer the powder the more uniform and economical would its distribution become. It was decided, therefore, to carry out further experiments in the following year, when the defects of the experiments would be remedied as far as possible, and smaller applications of the chemicals would be tested.

**Dry Spray Trials, 1920.**—These were carried out at two centres, viz. :—

(1) Mr. H. Beachell's farm, near Market Weighton.

(2) Mr. Wilson's farm, Garforth, Leeds.

The same substances were used as in the previous year, with the difference that a new supply of ground nitrolim was obtained, and the sulphate of copper was supplied by a local firm of manufacturing chemists in a much more finely ground state than that used in the 1919 trials. It was decided to test the respective substances in the following quantities :—

| | | | |
|---|---|---|---|
| Sulphate of Copper | ... | ... | 30 lb. per acre. |
| ,, ,, ,, | ... | ... | 20 ,, ,, ,, |
| ,, ,, ,, | ... | ... | 10 ,, ,, ,, |
| Nitrolim ... | ... | ... | 100 ,, ,, ,, |
| ,, ... | ... | ... | 50 ,, ,, ,, |
| Sulphate of Iron | ... | ... | 100 ,, ,, ,, |
| ,, ,, ,, | ... | ... | 50 ,, ,, ,, |

At the Kipling Cotes centre 10 plots each 1/20th acre were marked out in a field carrying Barley, and an abundant growth of Charlock. When, however, the actual amounts of the spray powders to be used per plot were calculated, they were found to range from 8 oz. to 5 lb., and it was feared that any quantity less than 5 lb. could not be easily distributed over the plots with the knapsack spraying machines at our disposal. It was therefore, decided to make up the bulk in each case to 5 lb. with some inert substance, and Silica was chosen for this purpose. In order to ascertain whether this diluent might in any way, either by absorption or mechanical obstruction of the spray powder, tend to weaken its chemical action, it was decided to put in a control plot to the plot of sulphate of copper at 30 lb. to the acre, in which only 1 lb. instead of $3\frac{1}{2}$ lb. of Silica was added.

The final treatment of the plots was as follows :—

| | | *lb. per acre.* | *lb. per plot.* | *lb. of Silica added per plot.* | *Total wt. (lb.) Spraying Powder.* |
|---|---|---|---|---|---|
| Plot 1. | Sulphate of Copper | 30 | $1\frac{1}{2}$ | $3\frac{1}{2}$ | 5 |
| .. 2. | ,, ,, ,, | 20 | 1 | 4 | 5 |
| .. 3. | ,, ,, ,, | 10 | $\frac{1}{2}$ | $4\frac{1}{2}$ | 5 |
| .. 4. | ,, ,, ,, (Control for Silica). | 30 | $1\frac{1}{2}$ | 1 | $2\frac{1}{2}$ |
| .. 5. | Untreated | — | — | — | — |
| .. 6. | Nitrolim | 100 | 5 | 0 | 5 |
| .. 7. | ,, | 50 | $2\frac{1}{2}$ | $2\frac{1}{2}$ | 5 |
| .. 8. | Untreated | — | — | — | — |
| .. 9. | Sulphate of Iron | 100 | 5 | 0 | 5 |
| .. 10. | ,, ,, ,, | 50 | $2\frac{1}{2}$ | $2\frac{1}{2}$ | 5 |

Arrangements had been made for spraying the crop much earlier in 1920, when the Charlock was about 3 in. high, but

unfortunately a very unsettled spell of wet weather set in at the time, and the operation was perforce postponed until June 4th. By that time all the plants were practically in flower, but very little seed had been set. The Barley was 6 to 8 in. high.

As in the previous year, the spraying was carried out at dawn in the hope of finding a good dew on the plants; but the weather was very unpropitious—there was no dew, and, to make matters worse, a moderately strong wind was blowing. The leaves, however, were slightly damp from rain, which had fallen during the night, and the experiment could no longer be delayed.

The plots were examined on June 21st, 17 days after treatment. The Charlock was still in full flower, and from a distance two green patches, afterwards discovered to be Plots 1 and 4, stood out clearly in the surrounding blaze of yellow. The following notes were made:—

Plot 1. About 75 per cent. of the Charlock had been destroyed, and the remaining plants were weakly, and much dwarfed.
.. 2. The leaves of the plants were badly damaged, and about 50 per cent. of the flower heads destroyed.
.. 3. Plants slightly damaged.
„ 4. About 85 per cent. of the plants were dead. This was decidedly the best plot of the series.
.. 5. Untreated.
„ 6. } These plots showed no improvement on the untreated plots.
„ 7. }
„ 8. Untreated.
.. 9. Here the spray had evidently been badly distributed. On that half of the plot at which the spraying was started, the effect was as great as on Plot 4, but, on the other half, not more than 30 to 40 per cent. of the Charlock had been killed. One may assume, therefore, that the first half of the plot had received at least twice as large a dressing of the spray as the second half—say at the rate of 150 lb. to the acre.
.. 10. Practically no effect.

As regards the crop, the Barley on the sulphate of copper and the sulphate of iron plots showed marked yellowing four days after the spraying, but, on the final examination on June 21st, it had quite recovered, and showed no signs of damage.

On the whole the results of these trials were better than had been anticipated, but it was felt that their value had been seriously depreciated by the unsuitable weather conditions, which prevailed at the time of spraying. The season was very backward, especially in the West Riding, and as the Charlock there was still in full flower, it was decided to repeat the experiment in a

modified form on the farm at Garforth on which it was carried out in 1919.

A comparison of Plots 1 and 4 in the Kipling Cotes experiment led us to believe that the presence of a large proportion of Silica in the spraying mixture had exerted some inhibitive effect on the action of copper sulphate. In making up the required quantities of chemicals for the Garforth trials, therefore, a much smaller proportion of Silica was added to make up the bulk, and greater care was taken in the spraying to ensure an even distribution on the plots. It was decided to omit nitrolim from the test, and to include only one plot of sulphate of iron. The latter substance is approximately $2\frac{1}{2}$ times cheaper than sulphate of copper, but this advantage is more than outweighed by the larger quantity which appears to be necessary to give results comparable to those of sulphate of copper.

Five plots, each 1/60th acre, were marked out in a field carrying Rye and Vetches—a thin crop which was spring sown. There was an abundance of Charlock, which, on account of the wet season and the open nature of the crop, had made luxuriant plants bearing a quantity of flowers and seed pods. The following table gives the treatment of the plots together with the actual amounts of the chemicals and Silica applied to each :—

| | | *lb. per acre.* | *oz per plot.* | *oz. Silica per plot.* | *Total oz. Spraying Powder per plot.* |
|---|---|---|---|---|---|
| Plot 1. | Sulphate of Copper | 40 | $10\frac{2}{3}$ | $2\frac{1}{3}$ | 13 |
| „ 2. | „ „ „ | 30 | 8 | 5 | 13 |
| „ 3. | „ „ „ | 20 | $5\frac{1}{3}$ | $7\frac{2}{3}$ | 13 |
| „ 4. | „ „ „ | 10 | $2\frac{2}{3}$ | $10\frac{1}{3}$ | 13 |
| „ 5. | Sulphate of Iron | 50 | $13\frac{1}{3}$ | 0 | $13\frac{1}{3}$ |

The field selected for spraying was adjacent to the University farm at Garforth, and it was thus possible to await favourable weather conditions for the operation. This was carried out on June 19th at 3.45 a.m. The weather was very hot, and a thunderstorm occurred at 9 o'clock on the previous evening, after which a heavy mist hung over the ground from midnight onwards. In the morning the air was very calm, and every leaf was drenched with moisture. No rain fell for 48 hours after the spraying, and the weather conditions may be considered to have been ideal.

*Results.*—After two or three days the plots presented a remarkable appearance, and it was evident that the experiment was a complete success. The previous experiments had shown, however, that the full effect of dry spraying could not be judged

Untreated.

Sulphate of Copper,
40 lb. per acre.

Sulphate of Copper,
20 lb. per acre.

Sulphate of Iron,
50 lb. per acre.

for ten days or a fortnight after the application, and for that reason only the notes made on the second examination on June 30th are given here. These were as follows:—

Plot 1. Sulphate of Copper—40 lb. per acre
„ 2. „ „ „ —30 „ „ „ } The whole of the Charlock plants had been destroyed. Even the large seed pods were dead and shrivelled, and the plants looked like dead sticks.

„ 3. Sulphate of Copper—20 lb. per acre. All the leaves and flowers were dead, and the great majority of the seed pods were too badly shrivelled to ripen seed.

„ 4. Sulphate of Copper—10 lb. per acre. 75 per cent. of leaves and flowers were dead, and much damage had been done to the seed pods.

„ 5. Sulphate of Iron—50 lb. per acre. 50 per cent. of leaves and flowers were dead, but the seed pods were very little injured.

A week later, bunches of the Charlock plants pulled at random from the respective plots were photographed, and those from Plots 1, 3 and 5 together with a bunch from the untreated part of the field are shown in the illustration. The flowers at this time had disappeared, but seed pods on the specimens gathered from the untreated part of the field and from Plot 5 may be easily seen. As regards the crop, the Rye, although slightly yellowed at first, showed no permanent injury on any of the plots, but the Vetches were rather badly damaged, particularly on Plots 1, 2, and 3.

It should be mentioned that in dry spraying with a Knapsack machine it was found necessary for the operators to wear respirators, since the fine dust of the sulphate of copper spray tended to produce nausea. A simple respirator made of two or three thicknesses of gauze was found to give complete protection. It is very possible, however, that this precaution would be unnecessary in the case of a horse-drawn machine, where the operator is seated at some distance from the spraying nozzles.

**Conclusions.**—(1) The success in dry spraying for Charlock lies in the choice of a suitable day for the operation. The weather should be fairly settled, and there should be a heavy dew and no wind at the time of application. Provided these conditions prevail, we may say confidently that dry spraying is quite as effective as wet spraying.

(2) Of the substances tested, nitrolim was found to be of no value, sulphate of iron was effective only in quantities, which, on the ground of cost, make it impracticable, but sulphate of copper gave excellent results.

(3) The Garforth experiment of 1920 shows that when the sulphate of copper is finely ground, an application of 20 lb. to the acre is sufficient to destroy the Charlock plants, provided seed has not set. In the majority of reports of experiments on Charlock spraying, emphasis is laid on the necessity of spraying the plants when in the third or fourth leaf, but, from our experience, we are inclined to think that the best results are likely to be obtained if the spraying is carried out just as the plants are bursting into flower. The flower-heads are very easily killed, and the leaf surface exposed to the action of the spray is at this time greater than in the case of younger plants. The effectiveness of the spray is thus increased, and the plants are less likely to recover.

(4) There appear to be a number of Dry Spray machines on the market. We have not tested any of these personally, but some of them should be easily adaptable to the spraying of Charlock. Two of those which have been brought to our notice are said to distribute quantities as small as or smaller than 20 lb. to the acre, and this being the case, the necessity of adding any diluent to the sulphate of copper, as was done in the Knapsack machine, would no longer arise.

(5) A comparison of the relative cost of Wet and Dry Spraying shows that, in this respect also, the latter process compares very favourably with the former. In wet spraying, the formula recommended by recent trials is 16 to 20 lb. of copper sulphate in 40 gall. of water, this making a solution sufficient to spray an acre. In dry spraying, we have suggested 20 lb. of copper sulphate to the acre; in this case, however, there will be a slight additional charge for grinding the material, but this is not likely to exceed 5s. a cwt. On the other hand, the labour entailed and the time expended in the newer process is very considerably less than that required in the older.

We consider, therefore, that provided an efficient machine is used for the purpose, the destruction of the Charlock pest by dry spraying should recommend itself to many farmers, and in particular to those who live in the more waterless districts of the country, where the older method has always been so heavily handicapped.

We wish to express our thanks to Mr. H. Beachell and Mr. Wilson for their kind co-operation in carrying out the trials on their farms, and also to Mr. J. Manby, of the University of Leeds, for the photographs.

# "RURAL BIAS" IN SECONDARY SCHOOLS:

## THE WORK AT SEXEY'S FOUNDATION SCHOOL IN SOMERSET.

S. L. Bensusan.

At first sight there is little remarkable about Sexey's Foundation School. The buildings that compose it are perhaps more than ordinarily attractive and certainly the situation is quite out of the common. Sexey's stands rather high on land overlooked from a distance by the Quantocks, the Mendips and the famous Dunkery Beacon. From the upper rooms of the School House one can glimpse the Islands of the Severn Sea. The school itself is remote from all great centres of life and action, though within touch of places boasting the most interesting associations. Cheddar is some five miles away, Glastonbury ten, Wells about as far, and the first thought that strikes the casual visitor is that those who teach and those who are taught must admit that their lines are cast in pleasant places. But Sexey's could hardly claim the attention of agriculturists if it were merely an attractive and well-placed secondary school; the special interest lies in the fact that it is one of the few centres in England in which secondary education is associated with what is known as a "rural bias."

There are many agriculturists in this country who feel very strongly that the development of husbandry would be furthered considerably if secondary education took more note of our greatest national industry. They would like to see children who have a natural aptitude for land-work encouraged to develop rather than forced to suppress it, and they believe that there is no more important problem before statesmen to-day than the repopulation of rural areas, with the great resultant stimulus to the production of home-grown food. They feel that, while in the old days the training that the boy or girl of farmer or farm labourer received was adequate to the demands that the future would make, the conditions have been altered entirely by the development of scientific investigation, by the advent of machinery, by the acquisition of precise knowledge and above all by the pressure of the economic situation. The State has recognised that pressure; it is spending considerable sums of money in the quickening of sound production, and consequently it is of first importance

that there should be an ever-lengthening procession through our secondary schools of boys and girls bent upon acquiring the special knowledge that will enable them to take advantage of modern conditions. The Board of Education is not unmindful of the new needs that the past few years have brought into being, and while expert opinion there is convinced that, if it is to be effective, secondary education must be an all round education and not limited in scope or purpose, yet certain concessions have been found possible. Provided that the curriculum of a secondary school embraces a modern language, some science and English, the "rural bias" is recognised and even encouraged. The new development is at present only in its first stage, and Sexey's is one of four secondary schools in which the "rural bias" may be seen in the working. Welshpool County School for Boys is another, Knaresborough Rural Secondary School in the West Riding is a third, and the Dauntsey Agricultural School at West Lavington in Wilts the fourth. In three years at Knaresborough thirty per cent. of the boys went on to farms, while others took to surveying or garden work or emigrated to the Dominions. At Welshpool out of 250 boys more than thirty per cent. went on to farm work or took up estate office work and surveying. At Sexey's where the majority of the pupils are associated directly or indirectly with agriculture the proportion that seeks a living from it is larger still.

Sexey's differs from Knaresborough and Welshpool in so far as it is a co-educational school, the boys and girls working in the same classrooms to a like end. While it is a secondary school by virtue of its four-year course for children who may come in at the age of twelve, there is a preparatory side for boys and girls, so that it is possible for a child whose training and associations suggest the possible development of an agricultural bias to start at Sexey's and receive complete education there.

The support received for this farm, which is of course a branch of the school and was a subsequent addition to it, comes from many sources. The original foundation was the Manor of Blackford, left by Hugh Sexey, Auditor to Queen Elizabeth and James I, for educational and other purposes in the year 1617. Out of funds provided by this foundation a school was built, and when the Rev. Edward Smith, who had been Instructor in Agriculture under the Wiltshire County Council, was asked to take charge of it, his keen interest in farming

FIG. 1.—The old building as it was. Note the windows boarded up.
(See Fig. 2).

FIG. 2.—The same building as a Farm School.

led him to consider the question of establishing a training farm within easy reach. A stone's throw of the school there was a small holding of some twenty acres or so, derelict for many years, the rich land gone to waste, the little farmhouse boarded up (Fig. 1). It should be remembered that this was more than twenty years ago when agriculture was at a very low ebb and even those who farmed the rich Somersetshire land were hard pressed to make a living. Mr. Smith was of opinion that the possibilities of improvisation, if grasped by boys and girls who have a natural instinct for land work, would provide them with a key that would open many a door through which, in normal times, only those could hope to pass who are plentifully supplied with the world's goods. He acquired the derelict holding, and being a skilled practical man with quick eye and trained hand, he managed to convert the farmhouse into a farm school (Fig. 2) at the trifling expense of £150. Those who have any working acquaintance with the present cost of adaptation will be astonished to realise how much could be done with a very little so recently as twenty years ago. The ground floor of the farm has been divided up into a dairy, a cheese-making room, a cheese-store for ripening and an incubator house. Beyond these there is a workshop, a milking byre, a pigs' kitchen and a cider house. On the upper floor there is a delightful little classroom with well-equipped agricultural library, and there are other rooms for the study of methods of fruit storage and for demonstrations in seed ripening and apiary work. Beyond the farm there is one outhouse that has been supplied with power for the economic handling of every farm product and its adequate preparation as food for stock. The mixing floor is concreted and the motor is driven by electricity supplied from Wedmore a mile or so away. There is a cow house and an up-to-date poultry station, and there are piggeries.

A special and notable feature of this small farm is that the actual work is not done by the pupils. Mr. Smith holds very strong views on this matter, and is of opinion that it is not right to ask any of his boys or girls to do work that should command payment. Yet although the total grant in aid of the farm school is limited to about £200 a year—a Grant from the Board of Education, the regular Grant to Secondary Schools, and school fees—the farm maintains three men at the standard wage and supplies the school, with its 150 pupils and resident staff of nearly a dozen people, with all the fruit, vegetables, eggs, milk, butter and bacon consumed.

The great difficulty that the school has had to face on its farm side is the postponement of the operation of those provisions of the Act of 1918 by which parents were compelled to keep their children at school until the age of 16. The training at Sexey's being thoroughly practical and modern, attempts have been made by parents who are working farmers to withdraw their boys and girls before they have completed their course, because they find that after a couple of years or less in the farm school they can replace a skilled man.

Mr. Smith finds as a result of his long experience that in addition to giving the main school "rural bias" the foundation of the farm school serves to provide fitting occupation for those boys and girls on whom a purely academic training would be wasted, while affording opportunities to those who show a special aptitude and wish to travel beyond the boundaries of ordinary farm work to prepare for an agricultural college. Pupils come from all parts—from local elementary and private schools, from secondary schools, and in some cases from the Continent. Perhaps because Mr. Smith is a very keen botanist, botany is the foundation of much of the outdoor practical work of the farm school. In fact every pupil has two years of botanical work, theoretical and practical, before the farm school can be reached.

Naturally all demonstrations are carried out on a small scale, but it is abundantly clear that effectiveness is not a matter of acreage. There is a quarter of an acre of garden land kept under every variety of seasonal crop, so that the sequence of the market-gardener's work can be followed. There are greenhouses; there are cool and heated frames. In addition to delightful orchards there is half an acre of fruit garden in which fruit culture is taught in all its branches—grafting, budding, transplanting and the rest—while owing to the rich soil and the mild climate, transplanting work is carried on under conditions that must excite envy among those who have learned their orcharding on colder and less grateful lands.

The farm work itself embraces nearly all the problems that agriculturists must consider. For example, to take mangold cultivation, there is a plot some 110 yd. long and 11 yd. wide divided into three strips. One is manured with superphosphate at the rate of 4 cwt. per acre, sulphate of potash ½ cwt., nitrate of soda 1 cwt., salt 3 cwt. On the next plot the rates are superphosphate 6 cwt., sulphate of potash ¾ cwt., nitrate of soda 1½ cwt. On the third the rates are: superphosphate 8 cwt., sul-

phate of potash $1\frac{1}{4}$ cwt., nitrate of soda 2 cwt., salt 3 cwt., and beyond these three plots there is a little triangular piece on which mangolds are being grown without manure. A quarter-acre plot of grass land has been divided up, all having been dressed with potassic superphosphate at the rate of 6 cwt. per acre, while half has received in addition nitrate of soda at the rate of 1 cwt. per acre. The manurial value of each is carefully explained and the pupils can compare for themselves the actual results obtained. Elsewhere swedes are being grown on plots with farmyard manure applied at the rate of 25 tons per acre over the whole, while one half has an addition of superphosphate, potash and sulphate of ammonia, and the other has superphosphate, potash and nitrate of soda instead. Potatoes are grown under a variety of conditions. One plot has farmyard manure at the rate of 15 tons to the acre and is then divided up, one half receiving an addition of superphosphate, potash and sulphate of ammonia, the other superphosphate, potash and nitrate of soda, this additional manuring being the same as is given to the swedes. In addition to this there is another potato plot divided into five parts. The first has no manure at all; the second has superphosphate; the third superphosphate and potash; the fourth superphosphate, potash and nitrate of soda; the fifth superphosphate and nitrate of soda but no potash. Here too the pupils will be able to see for themselves the effect upon the yield of crop. The use of machinery and its value on the farm have not been forgotten and the necessary attention is given to farm book-keeping, farm correspondence and costs.

The ordinary course in agricultural science is open to boys and girls of the school between the ages of 15 and 17 who have reached the fifth form or can give evidence of having received public secondary school education up to the fifth form of the school from which they have come. In addition to farm book-keeping based on the year's accounts of the school farm, the course of study includes land measurement and surveying, the theory and practice of dairying—including laboratory practice, the use of the Gerber tester, the clean production of milk, the making of butter and cheese, the feeding and care of live stock, including the preparation of rations on a scientific basis, and the principles of land cultivation and manuring on grass land, arable and moor.

The Somersetshire orchards are unfortunately more remarkable for their beauty than for the state of their preservation, and a spirited effort is being made at Sexey's to teach students the

value of pruning, spraying and a general clean up of dirty trees. In order to make the lesson memorable, some trees are cared for and others are left alone, so that the comparison is clear and obvious. Cider making is also undertaken by pupils, and in the laboratory they carry out qualitative analyses of feeding stuffs, manures and milk. The principles of drainage and elementary physiology are included in the curriculum, and practical demonstrations in bee-keeping are part of the summer term's work. The course for girls includes all branches of dairy work, book-keeping, correspondence, poultry-keeping, and a study of foods and feeding, together with practical gardening, fruit culture, fruit storage and preservation. Pupils have taken County Agricultural Scholarships, both senior and junior, and some have found high places in Agricultural Colleges and elsewhere. The practical work is associated with frequent lectures so that those who learn may understand the principles underlying their teaching.

By reason of the Government grant for secondary schools and with the aid of the County Authorities, the Board of Education and Sexey's Foundation, it is found possible even in these days of high prices to charge the parents of boarders no more than £42 a year for board, lodging and books. Moreover—and this perhaps is one of the most important aspects of the whole undertaking—the terms under which the school is conducted provide that 25 per cent. of the admissions in any year must be free of charge, and this has a particular significance in view of the "rural bias" because it means that for every hundred pupils who can pay there must be the fixed proportion of those who are unable to do so. Here is the chance for the child of the agricultural labourer. It is not sufficient to give the agricultural labourer the minimum wage, because it leaves him without prospects and he sees no better future for his children than that of the so-called "unskilled worker." He wants something better, and here in the remote Somersetshire Country he finds what he needs. At the present time 40 per cent. of the children at Sexey's are not paying pupils.

It is interesting to note that Sexey's School started in a barn and was not housed in its present attractive quarters until the success of the undertaking had been proved beyond all question. The Farm School was added to the premises as a going concern about the year 1913, when Mr. Smith handed over the buildings to the School Authorities. To-day the full limit of the accommodation has been reached, and so great is the school's popularity

that vehicles ply daily between Cheddar and Blackford to take pupils to and from the railway station.

It does not require any special gift of vision to see in the secondary schools with a "rural bias," of which Sexey's is so pleasing an example, a prospect that may go far to change the outlook of those who work on the land. It is admitted on all sides that no class of our population has done better work for the country or has received less return for it in years past than the agricultural labourer. The War brought these truths home to the community at large, and the worst of the farm labourer's disabilities have been removed by the Agricultural Wages Board and the Agriculture Act, while Village Clubs and Women's Institutes have developed the social side of rural life with the very happiest results. But this is not enough. The agricultural labourer's children have a right to be prepared to help the community at large by the development of their natural aptitudes along the most familiar lines. Welshpool, Dauntsey's, Knaresborough and Sexey's may constitute a small beginning, but as the knowledge of these undertakings grows and the value is recognised by the community it is not too much to hope that we shall see the "rural bias" a feature of secondary schools in all suitable districts, and that year by year they will send out a steadily increasing number of skilled workers on to the land. The expense is trifling; the reward is great; and in giving every encouragement to such a movement as this, the State will be recognising in very practical fashion its debt to those who have raised a considerable part of the nation's food in most disheartening conditions for many years. The rising generation should prove capable, in the new circumstances that will follow, of increasing the output to a point at which we shall stand far nearer self-support, and the security that attends it, than we are to-day.

# HOP-"MOULD" AND ITS CONTROL, I.

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**Introductory.**—The disease known variously as " mould," " red mould " or mildew is the cause in many seasons (*e.g.*, in 1920) of serious financial loss to the hop-grower. The other serious disease of the cultivated hop is the " fly " or hop-*Aphis*. The modern hop-grower has fully acquainted himself with the life-history of the *Aphis* and when it arrives he " washes " the hop garden with such energy and technical skill that even the most persistent attacks are kept under.

The cause of hop-" mould " has only comparatively recently been understood by the hop-grower. The farmer who still believes that " mould " is due to certain atmospheric causes or to the unhealthy condition of the sap of the hop-plant caused by errors of cultivation or manuring is now rarely met. Most farmers now not only recognise that " mould " is of fungous origin, but know the main points in the life-history of the particular fungus concerned. Prof. J. Percival and Mr. A. Howard, working at Wye College, largely helped in the spread of this knowledge. The late Mr. W. H. Hammond, a hop-grower as well as scientist, was the first to point out* that " red mould " and " mould " were two forms of the one disease.

The fact that at the present day " mould " takes far too heavy a toll of the crop in many quarters is due chiefly to the following causes :—(1) Although the use of sulphur (an efficient remedy against " mould ") is general, the farmer does not, as a rule, use it early enough in the season. (2) The thorough control of " mould " is dependent upon the taking of many *indirect* measures, some of them cultural. (3) Too often the hop-grower depends upon some utterly fallacious measure for controlling the disease.

It is the object of this article to treat the subject of " mould " fully from these three standpoints.

**Life-history of the Hop-" mould " or Mildew.**—A photograph of a hop-leaf with several spots of " mould " is given in *Fig. 1*. The general appearance, under a strong magnifying glass or microscope, of a spot of hop-" mould " is shown in *Fig. 2*. The " spawn " (*mycelium*) of the fungus (*Sphærotheca*

* *Journ. S.E. Agric. Coll.*, IX, p. 19 (1900).

*Humuli* (D.C.) Burr.)—composed of a mass of interlaced fine white branched threads (*hyphæ*)—creeps over the surface and at short intervals sends minute branches—the " suckers " (*haustoria*)—from the under surface of the threads into the cells of the hop-leaf or " hop." These suckers extract from the sap of the hop-plant the food the fungus requires—much as the needle-like proboscis of the hop-*Aphis* does when this insect is feeding. From the spawn upright branches (*conidiophores*) arise, each bearing a necklace-like chain of summer-spores (*conidia*)* (*Fig. 2*).

As each summer-spore (*conidium*) at the top of the chain becomes ripe, it separates and becomes free (*Fig. 3*), fresh spores being formed below as the top ones become ripe and fall off. In this way myriads of spores are produced in favourable weather conditions and accumulate in white, " powdery " masses over the surface of each spot of " mould "—a condition indicating infallibly that " mould " is " on the run." These summer-spores serve for the rapid propagation of the fungus, and being exceedingly minute and light they are easily carried by the wind for distances of a mile or more. This manner of distribution accounts for the fact sometimes to be noticed that an epidemic of " mould " appears suddenly in a hop-garden hitherto entirely free. If our eyes were able to observe such small objects—or if the summer-spores were much larger—we should frequently see in the air during summer in hop-growing districts a white dust-like cloud composed of myriads of these spores—much as we often see masses of " thistle-down " blowing about. Prof. F. M. Blodgett has computed that on a square inch of leaf-surface covered with hop-mildew 2,800,000 summer-spores are produced, and remarks† " from this it will be seen that, while the large majority of these spores may perish, there may still be enough left on a single leaf to infect a whole hop-garden."

Each summer-spore behaves like a seed in giving rise to a new individual. On reaching a healthy leaf or " hop," it at once proceeds to infect it; it puts out a root-like germ-tube, with a terminal knob (*appressorium*) which attaches itself firmly to the surface of the hop-plant (*Fig. 4*). Within 24 hours a sucker is produced from the under surface of the knob. The sporeling, or young fungus, is now both firmly anchored and supplied with food: it rapidly develops the threads of the spawn and, under favourable conditions, a " powdery " patch of " mould " with chains of summer-spores is produced within a week or ten days.

* These can easily be seen with a pocket magnifying glass.

† Cornell University, Agric. Exper. Stat., Bull. 328 (1913).

As each of the two million odd spores produced in a large patch of " mould " is able to propagate in this way, it is no wonder that the hop-grower, unless the earliest patches are dealt with, is often faced with sudden outbreaks of " mould " on an epidemic scale. The explanation of the efficacy of early sulphuring lies in the fact that the first powdery patches of mould formed in the season are killed before they have time to start hundreds of fresh infections in the neighbourhood.

So long as the hop-plant continues to produce fresh sappy growth, such as young leaves, lateral shoots, " runners," and the " burr " stage or young hop-cones, the mildew continues to produce its summer-spores. These spores, however, are quite unable to survive the winter months, when the hop-plant dies to the ground. It is important for the farmer to understand in what form and also where the "mould " survives from year to year, since ignorance on these points leads in many cases to the adoption of useless and expensive measures.

The stage in which the fungus passes the winter is far less noticeable than the white " mould." It can readily be seen with a pocket-lens, however. If during late summer the " mould " on the lower leaves is examined, minute round blackish-brown bodies (conceptacles) will be observed, usually densely clustered on the " spawn " (*Fig. 5*). Each conceptacle (*perithecium*) contains within it a transparent sac (*ascus*) holding 8 winter-spores (*ascospores*). These conceptacles are also found plentifully on " mouldy " hops. If a hop with " mould " or " red mould " is picked to pieces, hundreds of these dark, round bodies can be seen (with a pocket-lens) on the surface of the " petals " (bracts and bracteoles) (*Fig. 6*).

When the leaves decay, or when " mouldy " hops are left unpicked and allowed to blow away, the conceptacles with their winter-spores reach the soil of the hop-garden and remain there in security through the winter-months. The following spring—usually in May—these winter-spores are liberated in the following manner. Each conceptacle—when the weather conditions are right—absorbs water, swells and cracks open, exposing to view the inner sac (*Fig. 8*). The sac then likewise absorbs water and swells up, expanding like the envelope of a balloon (*Fig. 8*), until the tension on the expanding wall is so great that the sac bursts and the winter-spores are expelled forcibly through a slit into the air (*Fig. 8*). When thus liberated the winter-spores are wafted about by air-currents and some get carried to a hop-leaf—usually the lower leaves on the bine. The winter-spore

FIG. 1.—Hop-leaf, showing several spots of "Mould."

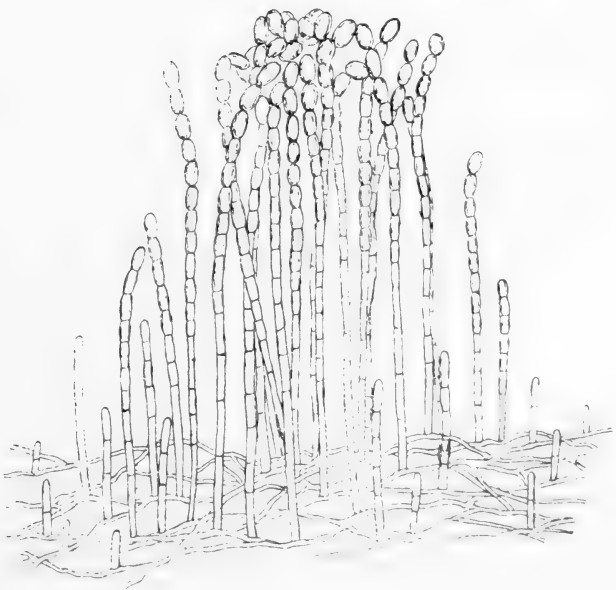

FIG. 2.—Young patch of "Mould," showing the creeping "Spawn" producing upright branches with chains of "summer-spores." Much enlarged.

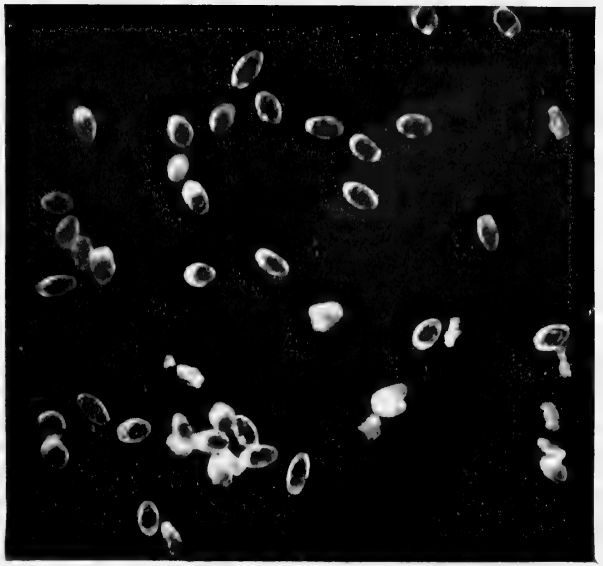

FIG. 3.—Photograph through the microscope of ripe, detached "summer-spores." Highly magnified.

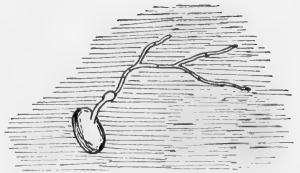

FIG. 4.—Drawing of a single "summer-spore" germinating on the surface of a hop-leaf. The "spawn" is just beginning to be formed; in 7-10 days it will present the appearance of a small patch of white "Mould," shown in Fig. 2. Much enlarged.

FIG. 5.—Hop-leaf with dark-brown patches of conceptacles (containing "winter-spores") forming on the "Spawn" of "Mould."

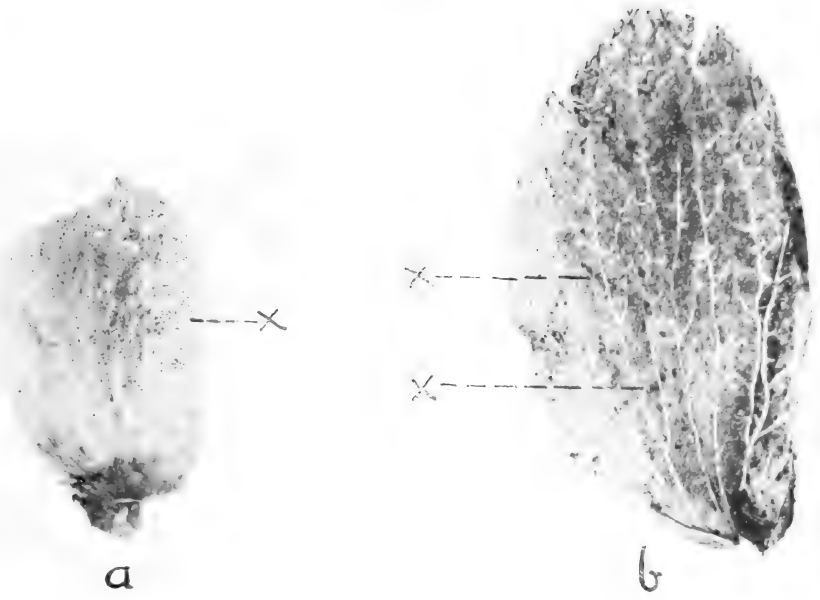


FIG. 6.—Two "Petals," (*a*, a *bract*; *b*, a *bracteole*) of a hop affected with "Red mould." The black specks X are the conceptacles containing the "winter-spores."

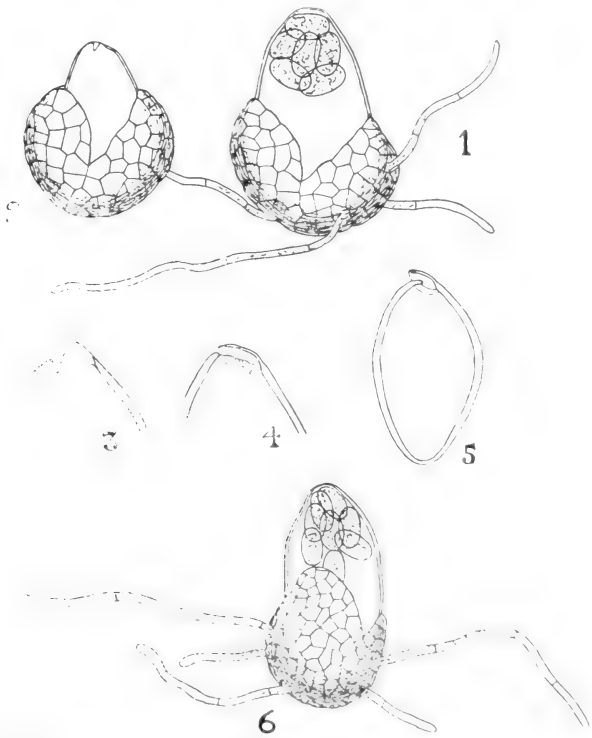


FIG. 7.—Conceptacles of hop-mildew bursting in the spring:—6, the wall of the conceptacle has just burst, and the inner sac has begun to swell up; 1, the sac has swollen up to its full extent, it then suddenly explodes, forcibly expelling the "winter-spores" through a slit (3, 4, 5) into the air; the empty sac then shrinks back (2).

FIG. 8.—A hop in "Burr," attacked by "Mould.'.


FIG. 9.—Drawings showing sulphur killing "Mould": *a*, a particle of "flowers of sulphur" destroying three chains of "summer-spores"; after three days. *b*, two branches bearing chains of spores; the one to which the particle of sulphur was applied showed, after three days, the terminal seven spores shrivelled up and dead, while the adjacent branch, approximately only $\frac{1}{800}$ inch away, remained unaffected. Highly magnified.

then germinates at once, infecting the leaf in exactly the same manner as the summer-spore does (*Fig. 4*), and in a few days a " powdery " patch of white " mould " is produced, bearing hundreds of summer-spores. Thus is brought about the *first or primary outbreak of " mould " for the season.*

As the result of infection by a single winter-spore there may arise, within three weeks, many hundreds of little patches of " mould " scattered through the hop-garden, unless by the use of sulphur during May and June the primary outbreak is smothered and killed before its summer-spores have time to spread. The hop-grower must realise that when in May and June he sees the " fly " arriving on his hops, at the same period the winter-spores of the mildew (unfortunately invisible) are being shot out of the soil and the first infections are occurring.

From the point of view of the practical farmer, the most important facts in the life-history of the hop mildew are (1) the fungus is confined to the surface of the above-ground parts of the hop-plant, never entering the " hill " or occurring on the roots; (2) during the winter months it exists only in the form of winter-spores within closed conceptacles which become dispersed over the surface of the soil of the hop-garden. The following year, about May, the winter-spores are liberated and produce at once the highly infectious white " mould." There is no living spawn existing through the winter.

**Damage caused by " Mould ":—**

(*a*) *To the Leaf.*—Although serious injury to the hop-leaf is seldom caused by "mould," it is essential that it is destroyed on the leaves, as otherwise the summer-spores produced there in immense numbers spread the disease to the "burr" and hop-cones where irreparable damage may be done. Further, it is comparatively easy to kill the mildew on the leaves, since the mildew is fully exposed and hop-leaves are easily sulphured, whereas " mould " on the hop-cones is difficult to deal with.

(*b*) *To the " Burr."*—The greatest damage is caused when "mould" attacks the "burr," *i.e.*, the female inflorescence which develops later into the hop. Each inflorescence when ready for fertilisation by pollen from a male hop shows a bunch of spreading branches (*stigmas*)—a stage called the "brush" by farmers. If summer-spores are carried by the air to the "brush," they readily infect it, it becomes white with "mould," and is soon converted into a hard white knob, with the result that no hop is formed. (*Fig. 8.*) The infection of the "burr" is usually brought about by summer-spores set free from powdery patches of "mould" on the hop-leaves in the same garden ; more rarely the spores are carried on the air from a neighbouring hop-garden infested with "mould." If the "burr" becomes attacked by "mould" it is impossible to save it.

Everything possible should be done, therefore, to help the hop plant to pass through as quickly as possible the critical stage when it is in "burr." If no pollen-dust from a male hop reaches the "brush," the hop remains in burr some 10 days longer than when pollen has been supplied, and then sets into a seedless hop, whereas if pollen reaches the brush, the "burr" stage passes quickly, and a large seeded hop is produced. It is consequently a wise precaution—as Mr. A. Howard first pointed out*—to plant a certain number of male hills in the hop-garden, more especially as it has now been conclusively proved that fertilisation of the "burr" is essential for the production of well-grown-out hops.†

(*c*) *To the Hop.*—Serious injury is very commonly inflicted by "mould" on the hop-cone in all stages of its development. All kinds of malformations of the cone may be met with; a very young hop may be entirely converted into a white "mouldy" knob, or the young cone may be "eaten into" on one side, or at the base or at the tip; or hops may occur which are normal in shape and size and yet diseased to the extent that many of its "petals" bear the conceptacles of the mildew. It is among the ripening hops that the condition so well known as "red mould" is met with. "Red mould" was long thought to be due either to the effect of certain atmospheric conditions (hot sun, mist, &c.), or to the attacks of some special parasite on the hop-cones, but it is now definitely established that "red mould" is nothing more nor less than white "mould," and the one can change into the other according to the part of the hop plant that is attacked. The name "red mould" is given to it on the ripening hop-cones, because under the attacks of the mildew the "petals" turn a foxy- or reddish-brown colour; very little "spawn" and few summer-spores are formed, hence the mildew does not become white nor resemble the "mould" elsewhere, but conceptacles with winter-spores are produced abundantly. It is one of the most insidious forms of the disease, and can only be dealt with by the rigorous suppression earlier in the season of all outbreaks of white "mould."‡

**Preventive Measures.**—*Direct.*—"Flowers of sulphur" (pure, sublimed sulphur) is the great specific against "mould," as all hop growers know. It should be applied much earlier in the season than is generally done. Owing to the fact that winter-spores arise from the soil during May, the first outbreaks of white "mould" for the season usually take place (unknown to the farmer) during that month. A good knapsack sulphurator should be employed to apply the sulphur to the leaves of the bines; the under surfaces of the leaves (which are usually infected first) should be well dusted over and a

* *Journ. S.E. Agric. Coll.*, XIV, p. 211 (1905).

† *Journ. Board of Agric.*, XX, 953 (1914).

‡ Last season (1920) reports were received of the prevalence of "red mould" in the hops of only those hills in the proximity of male hops ("seeders"). It seems probable, however, that in these cases there was no mould at all, but that the "going off" in colour (that was mistaken for "red mould") was due to the presence of partially over-ripe cones. Hops will not uncommonly show some of the "petals" which carry no "seed" at the base still of a bright colour, while those that are "seeded" have turned dark reddish-brown.

FIG. 10. Photograph, taken in October, of a part of a hop-garden *where the hops were not picked on account of "Mould"—a thoroughly bad practice.*

special dose given to the lowermost leaves. One good early sulphuring frequently prevents a bad outbreak of " mould " later in the season, and should never be omitted.* If " mould " has been noticed in the garden in the previous season, the knapsack sulphuring should be given once a fortnight until the lower leaves have been " stripped " off. Where a bad outbreak of " mould " has occurred during the previous season in the garden, or where the thoroughly bad practice has been followed of leaving " mouldy " hops unpicked, applications of sulphur with the knapsack pump, starting at the beginning of May, should be given regularly at intervals of a fortnight until the bines are high enough for the horse-sulphurator to be used. The number of applications necessary later in the season must of course depend on the extent and character of the outbreaks of " mould," on the weather conditions, and on the amount of " bine " in the garden. It is dangerous to tolerate patches of white " mould " at any time in a garden, as under certain weather conditions favourable for its propagation the mildew spreads with great rapidity and if this coincides with the period when the hop-plant is in " burr " or just in hop, irreparable damage may be done. Up to the time the " burr " appears any white " mould " in the garden should be promptly dealt with by sulphuring. It is the practice of many of the most successful hop-growers to sulphur the hops when in burr, not only as a preventive of " mould " but in the belief that the sulphur acts in some beneficial way, causing the " burr " to set into hops quickly. Generally speaking, no further sulphuring is necessary; should, however, " red mould " appear, applications of sulphur must be given until the hops are approaching ripeness.

In sulphuring with the horse-machine it is considered a good practice—since the sulphur is so light that it drifts in

* A striking instance of the efficacy of early sulphuring may be mentioned here. At the East Malling Research Station, in Kent, a new variety of hop, " The Foundling " (see this *Journal*, Vol. XXII, p. 136 (1915)) has been grown, amongst others, in the Hop Variety Trials. " The Foundling " has proved to be so specially susceptible to " mould " that nearly all the growers who have been testing it have abandoned its cultivation. The treatment of the hops at East Malling for the years 1918-20 has been as follows : *1918*, 5 applications of sulphur, viz., knapsack, end of May, early June, July 21 ; horse-sulphurator, Aug. 10, Aug. 17: *1919*, 3 applications, viz., knapsack, early June ; horse-sulphurator, July 24, Aug. 16 : *1920*, 2 applications, viz., horse-sulphurator, July 16, second week in August. In 1918 and 1919 there was no trouble with " mould." Mr. J. Amos, Manager Recorder, writes : " In 1920 the early sulphuring was omitted, which I must admit was a mistake, for I noticed that the hops were more ' mouldy ' than in the two previous years, as was also the case in 1917 when no early sulphuring was done. I shall make a point of having the early sulphuring done annually in future."

the air over several alleys—to take the machine down every second or third alley through the garden in the first operation, and then on subsequent occasions to go down the alleys previously missed. The sulphur will always readily adhere to any spots of " mould," but if a slight dew is present, it will stick better to the hop-leaf; absence of wind at the time of the operation is highly desirable, and such a condition is most frequently obtained in the early hours of the morning.

The purest " flowers of sulphur " should be used in all the operations, and such adulterated forms as " green sulphur," " black sulphur," " sulphur vivum " should be strenuously avoided.* Recent evidence gives ground for believing that sulphur does not act in a gaseous form, and that direct contact of the mildew with a particle of the sulphur is necessary for its destruction. Contrary to general belief, the heat of direct sunlight is not required in order to make sulphur efficacious in killing " mould." The writer has observed repeatedly in experiments that when a particle of sulphur adheres to the mildew, a slow shrivelling up of the fungus takes place, even when it is kept continuously in the shade (*Fig. 9*). In order to get the best results in sulphuring against " mould," the observance of two points is essential: (1) the " flowers of sulphur " must be of a brand guaranteed to be pure sublimed sulphur and free from admixtures, and (2) it must be in a condition of very fine, dry, dust-like particles free from lumps or " caked " masses. If the sulphur has become " caked " it must be passed through as fine a sieve as possible. The finer the particles the greater will be the number of points of contact, and a quicker and more thorough destruction of the mildew will be the result.

There seems little doubt that in wet weather " mould " is not kept under satisfactorily by " flowers of sulphur," probably because of the removal of the latter by the rain. Some growers use in dull or wet weather a solution of " liver of sulphur " (polysulphides of potassium or sodium). The strength usually advocated is from 1 to 2 lb. of " liver of sulphur " to 100 gal. of water or of " hop-wash." Experiments have shown† that a " liver of sulphur " solution of this strength does not kill hop-" mould," even when used with 10 lb. of soft soap to the 100 gal. of water, and that from 3 to 4 lb. of " liver of sulphur " is

* A sample of a much-advertised brand of "green sulphur" contained only 25 per cent. of sulphur, while the other constituents (including sulphate of lime (gypsum) 40 per cent.) were of no known fungicidal value.

† *J. V. Eyre* and *E. S. Salmon*, in *Journ. Agric. Science*, VII, 473 (1916).

required—a strength which would cause too serious a " scorching " of the hop-plant in summer. In common practice, the " liver of sulphur " solution is applied with the wash (usually soft soap and quassia) that is being used against the " greenfly " (*Aphis*). If this wash contains a higher percentage of soft soap than 10 lb. to the 100 gal., it is possible that good results are obtained in checking, if not killing, the " mould," since it has been found that " liver of sulphur " solutions become more potent when used with greater amounts of soft soap. It is questionable, however, whether sufficiently strong solutions of " liver of sulphur " (with soft soap) to kill " mould " could be used on hops either when in " burr " or just before (when the " pin " is showing) without causing serious " scorching " injury.* Strong solutions of " liver of sulphur " and soft soap, or the lime-sulphur wash (1 lb. of the concentrated wash to 29 gal. of water) can safely be used on the hop-leaves early in the season, but except in special circumstances their use would not prove economical. It is quite certain that at present " flowers of sulphur " must be regarded as the one safe and certain remedy against " mould."

(*To be concluded.*)

* The same danger would attend the use of the lime-sulphur or the ammonium polysulphide wash.

# POULTRY RESEARCH.

## AN URGENT NEED.

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ONE need not be particularly perspicacious to recognise the current vigour in and expansion of the poultry industry. The forthcoming World's Poultry Congress is in itself a clear indication of the rapid development that has taken place during the last few years; while the part Great Britain is to play at the Congress demonstrates the enthusiasm of the poultry specialist in this country.

When development is so obvious, and when poultry-keeping is becoming so popular, the question naturally arises: Is science taking an adequate share in the development? So far as the United States of America is concerned, the answer is that science is undoubtedly affording a very considerable and present help. The paper read by Mr. Edward Brown at the 1920 Harper-Adams Conference alone shows this. But the answer as applied to Great Britain is not so satisfactory. Work in poultry research has certainly been done, and is being done, but it may be reasonably affirmed, not to the extent nor in the organised manner that is so desirable. Credit must be given to the few who are applying time, thought and energy to the elucidation of problems relative to heredity, diseases, and the like, but workers in the enormous field of research are all too few. This is the more to be regretted because the machinery by which knowledge can be brought to those who are willing to apply it is in existence. Poultry lecturers there are in plenty, but they are only able to instruct the poultry-keeper up to the point at which present knowledge ends. Poultry investigators, on the other hand, are far too few, while their research is too sporadic. This is likely to remain so until adequate opportunities are given to those who would fain specialise in poultry research, but who must, for the present, make such research subsidiary to their main line of work. So many problems are clamouring for attention that the chance investigator is discouraged from embarking upon research while he sees little, if any, probability of being able to pursue it in a manner likely to lead to satisfactory results. However small the corner of the field upon which he casts his eye, he soon perceives that either he or someone else must attack areas outside that little plot.

**Factors controlling Artificial Incubation.**—There would be little difficulty in indicating problems the solution of which would greatly benefit the poultry industry. All those questions that centre around artificial incubation immediately suggest themselves, and it is, indeed, fortunate that a start has been made in this direction. So far as present indications go, Professor Chattock is in a fair way of revealing some of the factors controlling successful artificial incubation. Being artificial, it is reasonable to surmise that the factors are many, and it may be safely predicted that, the deeper the problems are probed the more widely will their ramifications be found to extend. New questions are bound to present themselves, but while these are waiting for answers, those solutions that have already been arrived at are available for practical application.

**Avian Reproduction.**—The phases of reproduction prior to incubation also offer wide scope for the investigator. While there are principles of the physiology of reproduction common to all the higher animals, there are many features of reproduction peculiar to birds. Obviously, phenomena long recognised and subjected to investigation in mammals must of necessity be absent in oviparous animals; and phases of the reproductive act that are of first importance in birds are inconspicuous in mammals. Seeing that the ovum of birds, as first formed in the ovary, is so small, it is evident that the formation of the other components of the egg—the yolk and the white—and the laws governing their formation, must always stand first in economic importance. The periodic production of relatively enormous quantities of albumen by the fowl has no exact parallel in the mammal. Clearly, then, the general and mammalian physiologist can scarcely be expected to give special attention to such processes, though they lie at the very root of success in the poultry industry. Not that the physiology of avian reproduction has been entirely neglected: much attention has been paid to it by American investigators. Yet no one with a knowledge of research workers' publications can escape the conviction that what has been discovered in this direction is but a tithe of what remains to be discovered before any practical application of the knowledge is possible.

**Problems of Reproduction.**—With the problems of reproduction as affecting egg-production, those of heredity are inseparably connected. The utility poultry keeper is probably not very interested in fine distinctions of plumage or in the size and shape

of the comb, but he is anxious to learn anything concerning the inheritance of factors that affect the number and size of the eggs, as well as the fattening qualities of the bird. Egg-laying trials serve an exceedingly useful purpose, but they do not necessarily throw a searching light on the subtler aspects of heredity. It is not difficult to understand that the trials can hardly be conducted with that regard for scientific precision demanded by the student of heredity, and that, therefore, more rigid control, and the recognition of precise rules of experimentation, may be regarded as necessary for the discovery of facts upon which laws may be formulated.

**Pathology of Reproduction.**—Reproduction, moreover, has its pathology. Not by any means of trifling economic importance are those obscure disturbances of the reproductive organs which, though not generally recognised as actual diseases, are yet sufficient to lead to faulty egg-production. These, too, require investigation.

**Research in Poultry Diseases.**—In the province of pathology and bacteriology, it is impossible accurately to estimate the benefits that would accrue to the poultry industry from discoveries arising out of research. There can be no question that the benefits would be many, and we may obtain some idea of them by a review of any one of the recognised diseases, as well as by a summary of the confessed gaps in current knowledge respecting its etiology and control. For such a review and summary almost any disease would serve, but an instructive example might be found in a disease of which few poultry-keepers have the good fortune to be ignorant. I refer to that disease or group of diseases known by a multiplicity of names—roup, diphtheria, bird pox, &c. In the forefront of many questions stands that of Cause. Is there one main factor? Or are there many? If it should be determined that there is only one causal agent, then how is it that such a gamut of manifestations can be induced? When these and many other doubts of a like nature have been cleared, there will arise an inquiry into the best and surest method by which the disease or diseases may be combated and controlled.

**Carriers of Disease.**—There is also the matter of "carriers." It is recognised that apparently healthy mammals may be "carriers" of diseases, and in avian pathology it is also recognised that an apparently healthy pullet may be a "carrier" of the virus of bacillary white diarrhœa. It is probable that fowls

may be " carriers " of other diseases, but investigation on scientific lines can alone prove this.

**Poultry Research.**—That pathological and bacteriological research will always be fruitful, in varying measure, is beyond question, and it cannot be doubted that any discovery in avian, no less than in mammalian, pathology will inevitably show that there is something further to seek. There is no finality in pathological research any more than there is in any kind of biological research. Those who are following modern thought in Medicine know that recently a change has crept into the conception of the causation of diseases due to bacteria. Time was when it was considered sufficient to recognise two factors in disease—the tissues of the animal attacked, and the attacking micro-organism. Now, however, experiments have hinted at the possibility of a third factor—or " third partner in disease," as it has been called—acting on the animal tissues and breaking down their defence, thus permitting the micro-organism to exert its pathogenic power. When the precise nature of the " third partner " has been disclosed, and the means of nullifying its effects have been devised—thus putting a further restraint upon the activity of the pathogenic organisms—research will proceed to an inquiry into the still more efficient control of the causes of disease. Whatever advance is made in pathological knowledge in general, will be possible of application to the control of avian diseases. Clearly, then, facilities and opportunities for the application of general knowledge to the special problems of poultry diseases cannot fail to lead to beneficial results.

While poultry research has a wide field in the investigation of diseases concerning which something, at least, is already known, it has an even wider field in the discovery of the true cause of many diseased conditions not yet clearly identified. Is it not true that even the poultry-keeper of wide experience occasionally encounters a condition that, in spite of his long acquaintance with the frailties of domestic birds, he has not previously seen, and to which he cannot give a name? The pathologist who has made a special study of avian diseases is often in the same position.

Among the numerous investigations that are awaiting the attention of research is that dealing with the action of drugs. From the very limited observations made, it is evident that the effects of drugs on birds cannot be predicted with certainty. This is not surprising, for it is well known that different species of mammals exhibit variation in their tolerance to toxic drugs.

from which it might be surmised that drugs would also affect birds in varying degree. Gallagher's experiments, though few in number, are sufficient to show that poultry have a distinct tolerance towards some drugs, while they are sensitive to others. Though it would be unwise to draw definite conclusions from experiments that are admittedly only preliminary, it is at least permissible to say that they demonstrate the need of investigations on the safety-point of solutions used as drinking-water.

It is unnecessary to detail all the directions in which profitable research might be undertaken, but passing reference may be made to the necessity for systematic inquiry into food values. In mammalian physiology, an enormous amount of work has been done, and is being done, to discover the most economical and most productive foods, and certain laws of nutrition have been formulated. But in avian physiology the subject has not received nearly the amount of attention it deserves. Discoveries in mammalian dietetics cannot always be applied to birds, because of differences in metabolism and outstanding differences in the physiology of reproduction. That the kind of food—apart from its quantity and admixture—has a marked influence upon the egg may be taken for granted, for it is well known that the colour of the yolk can be altered by the administration of certain foodstuffs. If, then, the colour can be affected, why not other properties? And why should not the white of the egg be affected as well as the yolk? Doubtless something of value could also be discovered from more extensive research on the question of insect proteins as a component of the diet of poultry. It has even been suggested that insect protein may have an influence on susceptibility to disease. But the whole subject of dietetics is very closely associated with liability to, and even production of, disease.

If, then, it is held incontrovertible that poultry research is necessary and would lead to results of economic importance, it may be asked: Under what conditions should it be prosecuted? It is possible that some would suggest a large central institution wherein all forms of research might be conducted by a specially trained staff, who would disseminate reliable information to those engaged in the poultry industry. There is much to be said for what may be called a clearing-house of knowledge, from which the poultry-keeper could obtain the information he desires, if available. But it is not so certain that centralisation of research would be altogether a good thing. There is a strong possibility that the workers, being isolated and not in contact with wider

and more general biological problems, would have their outlook narrowed. It seems probable that better work would be done in places where problems relative to mammals were also being investigated. Breeding experiments would be more fruitful of useful data if they were conducted alongside investigations bearing on the same questions as applicable to animals other than poultry. Investigations relative to dietetics could scarcely be profitably separated from the work of existing nutrition laboratories; nor would it be altogether wise to separate the study of avian diseases from that of mammalian pathology. On careful consideration, it appears probable that in practice the most satisfactory way of fostering poultry research will be found to be by encouraging existing institutions to extend knowledge that can be disseminated by a central organisation, to which the poultry-keeper may look for information, guidance, and advice.

# NOTES ON POULTRY-KEEPING.

THE development of egg production has to some extent operated against the revival of the table poultry industry, and at the present moment this is very apparent. With the exception of small supplies of "petits poussins" practically the only English poultry now reaching the markets are old birds. Fortunately for the consumer, American supplies of frozen chickens of very good quality are available. By the time these notes appear spring chickens should be ready for the markets in appreciable quantities, and poultry keepers are warned against holding back their supplies too long. The demand is for a chicken weighing 2 to 2½ lb., and although young birds of larger size may be even more favourably received it is seldom advisable to hold them over several weeks in order to attain this weight, since by so doing the best trade and the higher prices per lb. are frequently lost. Although the cost of feeding stuffs has fallen, the prices realised for table poultry are good.

In many instances, particularly when there is a lack of accommodation for the growing chickens, the poultry keeper is well advised to market his young cockerels as "petits poussins." These small birds sent to the market alive weigh from 10-12 oz. when, at the rate of 2s. 8d. to 3s. per lb., there is a fair margin of profit.

An indication of the comparative position of poultry foods at present, compared with this time last year is given by a comparison of the average wholesale prices of the staple poultry foods in London in corresponding weeks of 1920 and 21 :—

| | | *Week ending* | | | |
|---|---|---|---|---|---|
| | | *April 7th, 1920.* | | *April 6th, 1921.* | |
| | | £ s. | | £ s. | |
| Oats | per 336 lb. | ... 3 0 | ... | 2 4 | |
| Maize | „ 480 lb. | ... 3 19 | ... | 2 16 | |
| Middlings | „ ton | ... 13 10 | ... | 10 0 | |
| Bran | „ „ | ... 13 10 | ... | 8 0 | |
| Barley meal | „ „ | ... 25 10 | ... | 15 10 | |

Apart from the considerable reductions shown in these figures the quality of the offals in particular has vastly improved. Although figures for ground oats and proprietary foods largely used in chicken rearing during the early stages cannot be given, these will generally be found to have fallen at least proportionately, whilst there is an even greater improvement in quality.

**Chicken Rearing.**—By May a large proportion of the chickens have reached a stage when the pullets and cockerels will thrive much better if separated. Some difference in the feeding should be observed; young cockerels if kept in a soft and well-fed condition will require little if any fattening provided they are separated from the pullets, and they will then be ready for table at from 10-14 weeks old. They may be kept upon a restricted range, in a grass pen for preference, whereas the pullets will grow and thrive better with free run and a less generous diet.

Sussex ground oats or barley and maize meals with a due proportion of middlings should be given to cockerels in a wet mash twice daily, with a feed of wheat at night time. One feed of wet mash with a small feed of wheat at mid-day and a liberal feed of wheat at night will suffice for the pullets on a free range, but an additional wet mash is necessary if the range is limited. As an alternative under these conditions dry mash may be used in place of the wet mash.

**Young Turkeys.**—Unless the young turkeys have the range of meadows and hedgerows with access to nettles and other wild green stuffs of which they are very fond, troubles are likely to arise. The too free use of starchy foods in the dietary of turkeys is a frequent cause of loss, and an abundance of green food is essential. Insect life is also needed, and the provision of a substitute when the birds have a limited run is more difficult than in the case of chickens and ducklings. Young turkeys do not readily eat fish meal, but granulated meat of good quality and free from bone can be given, though the use of freshly cooked meat, bullock's liver and lights, finely chopped, is much to be preferred. Middlings, Sussex ground oats, and maize meal can be used—the two latter in moderation—and boiled rice if mixed with the meat. Practically 50 per cent. of the bulk of the food consumed by young turkeys should consist of fresh green stuff.

**Ducklings.**—The rapid growth of ducklings renders them particularly attractive to the rearer of table poultry. They are ready for market from 3 to 4 weeks earlier than a chicken and can be raised upon smaller spaces. Boiled rice constitutes one of the most valuable foods, but this cannot be considered economical at the present price. Middlings with maize and barley meal or wheat meal with 10 per cent. of fish meal should be used up to 5 weeks of age, after which the quality

of the flesh will be better if maize and fish meals are omitted. Fresh meat offals thoroughly cooked and including the fat should replace the fish meal. Boiled nettles, using the tea for mixing the meals, should be given at least once weekly from the time the ducklings are a month old. At this age boiled wheat forms a useful variety to the meals used, but uncooked grain is not economical for fattening ducks.

**Adult Stock.**—The use of nettles for adult poultry stock at this season is greatly to be recommended. With the advent of warmer weather many of the laying hens suffer from the generous feeding given during preceding months to maintain production. Several mashes of young nettles boiled to a pulp and mixed with the wet mash will have a very beneficial effect.

# THE NOMENCLATURE OF AGRICULTURAL PLANTS.

W. H. Parker, M.C., M.A.,
*Director, National Institute of Agricultural Botany,*
and H. Chambers, M.B.E.,
*of the Ministry of Agriculture and Fisheries.*

To anyone who has the future prosperity of British Agriculture at heart, one of the most hopeful signs of the times must be the fact that the farming community, hitherto noted for its extreme conservatism, is beginning, under the stress of modern conditions, to discard the idea that the ways of its fathers are invariably the best, and to demand that new methods of cultivation, new fertilisers and new varieties of plants shall be provided for its use.

Valuable as will be the ultimate effect of this new spirit, it has also its dangers, for what is " new " is not always an improvement on the old, nor is what is termed an " improvement " always what it purports to be. As in all matters, so here, demand has stimulated supply, and never has there been such a number of " new " and " improved " varieties of our different agricultural plants put on to the market as has been the case during the last few years, and every year that number increases.

This, in itself, is all to the good, for, as time goes on, it becomes more and more evident that there is no one variety of any agricultural plant which is ideal for all conditions of soil and climate found even in a small country like the United Kingdom. In fact there is room for any number of varieties of any species; and any variety which can be shown to be particularly adapted to any one district has, in fact, justified its existence. It is certain, however, that among all the named varieties now on the market, there are a large number which could, and should, be eliminated as being either identical with one another, or as being distinctly inferior, under any conditions, to their brethren.

**Present Situation in the United Kingdom.**—Though everyone with any knowledge of the subject is convinced of this superfluity, it is obviously difficult to produce any large amount of evidence concerning the extent of the trouble, for no trials in any country (except in the case of potatoes, fully dealt with later) have ever been made on a sufficient scale to afford

concrete proof, and where no conclusive evidence is forthcoming, it is impossible, on account of the proprietary interests involved, to give instances, however strong the presumptive evidence may be.

*Wheat.*—The above should be borne in mind when studying such a brochure as "Dunns on Seed Wheats"—the most complete modern catalogue of wheats which has fallen into our hands—for it is obvious that a publication of this nature cannot but be absolutely tied down to accepted fact. Even so, concerning the list which it contains of over 425 names, it says: "It is not suggested that they are all distinct varieties. Essex Rough Chaff, Kentish Red Chaff, Square Head's Masters have at least a dozen names, each in different localities." Seventy-five names are mentioned as being used for varieties still grown in the United Kingdom, but from the notes given it is obvious that they cannot represent over (but probably far less than) 60 varieties.

An additional complication arises out of the use in many cases of one name for several varieties; for example, there are white chaffed and red chaffed wheats both known as Browick, and it is the common practice to call all bearded autumn-sown wheats either Rivetts or Cones, and they include both red and white grained varieties.

*Oats.*—There is the same confusion in the case of oats; it is difficult to say how many different "varieties" are in existence, none of which show any visible difference from "Abundance." Mr. C. W. S. Marquand, of the University College of North Wales, Aberystwyth, states that, as a result of a study of a very large number of samples, he has come to the conclusion that many so-called "varieties" are *morphologically* indistinguishable, but that he is not yet in a position to express an opinion as regards their *physiological* identity.

*Grasses and Clovers.*—Here the position is somewhat different; the number of varietal names is small, but there is a profusion of strains with purely local, and probably mythical, reputations. Only a very small number are the result of conscious effort towards improvement, nor have their claims ever been submitted to crucial test. Mr. S. P. Mercer has already pointed out the confusion which exists where Red Clover is concerned, enumerating the following names which are in use without any strict adherence to any system by which it would be possible to tell whether the strains were of ordinary Broad Red, or of the true late-flowering type. "The names,

Red Clover, Cowgrass, Giant Cowgrass, Perennial Red Clover, Cow Clover, Single-Cut Cowgrass, Double-Cut Cow Clover, Late-flowering Red Clover (and probably others) appear to be used very much according to the taste and fancy of the user.''* There is also much confusion arising out of the promiscuous use of the term '' Wild white clover.''

*Vegetables.*—In the case of vegetables it is probable that the '' orgy of synonyms '' is more marked than in any other group of plants. Of the thousands of names of peas at present on the market there are probably less than 100 varieties, and these in turn include probably less than 20 types. Cabbages, turnips and beans also suffer from a multitude of unnecessary names.

*Potatoes.*—For more concrete evidence, it will now only be necessary to describe the state of affairs where potatoes are concerned. Here one is on safe ground, for, as stated above, this is the only crop which has been systematically and authoritatively dealt with in relation to synonymity.

As a result of the widespread importance attached by all those interested in the potato crop to the Ministry of Agriculture's annual trials for Immunity from Wart Disease held at Ormskirk, perhaps nowhere in the world are such a great number of varieties grown in such a limited area or under such uniform conditions. In 1915 the late Mr. John Snell, M.B.E., B.Sc., started to make records of synonymous varieties sent for test, and, since 1919, annual reports have been published on this subject.†‡ In the 1919 report† Mr. Snell suggested the several ways in which synonyms could arise, viz.:—

(1) The re-naming of varieties for trade purposes.
(2) The giving of a new name to a selection from an old variety, even though the selection may be indistinguishable from the variety.
(3) The propagation and naming of promising '' rogues '' found in fields of another variety, on the assumption that they are '' sports '' or '' mutations.''
(4) The stock of a new variety passing into the hands of two different introducers, each of whom names it.

* Report on A Survey of the Principal Seed-Growing Counties of England, Wales and Scotland (to be issued shortly by the Ministry of Agriculture and Fisheries).

†Supplement No. 18 to the *Journal of the Board of Agriculture*, March, 1919.

‡Ministry of Agriculture and Fisheries. Miscellaneous Publications. No. 28.

(5) True seedlings arising, which are identical with older varieties, or with other seedlings.

Though interesting, it is not necessary to dwell on this branch of the question.

In 1919, the work was transferred to a Committee, and in 1920 the National Institute of Agricultural Botany took over the responsibility of the appointment of this Committee, and the report for this year was written by its Chairman, Dr. Salaman, and published by the Institute.* For fuller details concerning the important work carried out since 1915 the reader is referred to the three reports mentioned. It will suffice, here, to confine our attention to synonymity among the named "varieties" submitted each year, ignoring unnamed seedlings which have, or (usually) have not, proved themselves to be novelties. The total given for each year consists of named stocks of potatoes which purport never to have been previously tested at Ormskirk.

| | *Total.* | *Synonyms.* | *Percentage.* |
|---|---|---|---|
| 1915 | 90 | 24 | 27·77 |
| 1916 | 81 | 21 | 25·92 |
| 1917 | 43 | 9 | 20·93 |
| 1918 | 93 | 39 | 41·93 |
| 1919 | 105 | 64 | 60·95 |
| 1920 | 135† | 92 | 68·15 |
| | 547 | 249 | 45·52 |

This would seem to show that the trouble is on the increase.

It may be objected that the mere fact of entering potatoes for trial cannot be taken to mean that it is intended to put them on the market. This argument would certainly hold good for unnamed seedlings, but these are excluded from the above figures, and it seems fair to argue that breeders or producers do not, as a general rule, name their productions unless they have some definite idea of submitting them to the public.

As a result of the publication of these findings, very few, if any of the above synonymous stocks have actually been sold commercially; this only emphasises more strongly the immense value of such a check, and how desirable it is that something of a similar nature should be undertaken in the case of other crops.

Evidence of the conservatism of the findings is supplied by

*National Institute of Agricultural Botany, "Report of the Potato Synonym Committee, 1920."

†Excluding stocks too weak in growth, or too mixed to be judged.

Mr. Findlay,* who enumerates 148, among the potatoes which he has himself tested, as being synonymous with either Duke of York, British Queen, Abundance or Up-to-date. Of these, 48 have also been grown at Ormskirk, and in 38 cases there is agreement both as to synonymity and type. A larger discrepancy might have been anticipated, for at Ormskirk the Synonym Committee does not pronounce a stock to be a synonym save with the concurrence of every member (six in 1920); thus, at Ormskirk there is a greater likelihood of a stock being given the benefit of the doubt than where, as in Findlay's case, the decision rests with a single judge.

**Harmful Consequences.**—Such chaos as has been shown is obviously bad. It prevents the raiser of a good new variety from reaping the full value of his discovery, as the name he selects will be lost amongst the many new names that are continually appearing. It makes it necessary for the seedsman to list and stock many so-called different varieties of the same kind of seed whereas probably half the number would be sufficient so far as any real difference in the varieties is concerned. It also entices the grower to purchase seed because it has an attractive new name, whereas seed which will produce exactly similar crops could in many cases be purchased at probably a lower price under the name of its parent.

It is not implied that wilful misrepresentation is habitual, or even common, among British Seed Producers or Dealers, but a very small minority can do a great amount of harm. In general, our present position must be attributed to the complete lack of any means by which a variety can be submitted to adequate comparative test before it is put on to the market. No single firm could possibly undertake the highly technical tests which would be necessary to ensure complete knowledge concerning its productions, and even if the attempt were made, such a firm would only penalise itself to the advantage of its less careful competitors.

Nevertheless immediate action is called for. The present situation is undesirable, as worthless or inferior varieties are being kept alive when they deserve to die, and they are continuing to occupy land which should be growing more valuable productions.

**Remedial Measures Abroad.**—It is recognised that the evidence given concerning our British crops is not conclusive, but

* Wm. M. Findlay, "Potato Synonyms." *The Scottish Journal of Agriculture*, April, 1920, pp. 202-207.

it only requires a short investigation into the action being taken in foreign countries to convince us of the seriousness with which they view the present situation. In every case where any attention has been paid to the matter, it has been decided that the facts have justified the adoption of some scheme by which the trouble may be diminished.

*Germany.*—For the general system of seed improvement, the reader is referred to the *Journal of the Board of Agriculture* for June, 1909. Crop nomenclature is controlled by a Committee of the German Agricultural Society, whose main activities consist of the Registration of Pure Bred Seeds, the " Recognition " of stocks of superior varieties, variety trials, &c.

Registration of all plants of agricultural importance in the Official Register is permitted on submission of satisfactory evidence, derived from independent trials, that an improved variety has been produced, but proof must also be given that this improvement is the result of conscious efforts carried out through a series of years on the stock in question. A sub-committee of experts decides the eligibility of stocks, and admission gives the producer the exclusive right to describe his seed as " entered in the Pure-Bred Seed Register of the German Agricultural Society " and to use a legally protected trade-mark. Mr. E. S. Beaven* has already pointed out of what great value such a system would be in England, but so far no steps have been taken in this direction.

" Recognition " is granted to the seed-crops of Members of the German Agricultural Society after the growing crop has been inspected by experts of the Society, who must satisfy themselves that it is a pure sample of a variety of proved worth, that it is being grown under favourable conditions, and that harvesting arrangements are satisfactory. Recognition only applies to the actual crop inspected.

All registered seed has also to be " recognised," but recognition is also open to growers (who are not the actual breeders) of seed of first-class varieties, and to breeders whose varieties have not gained admission to the register.

It is obvious that fictitious novelties are excluded, by the above conditions, from both registration and " recognition."

Variety Trials are carried out on an extensive scale all over Germany, not only by the Society itself, but also in conjunction with other Agricultural bodies. The trials are conducted on a

* *Journal of the Royal Agricultural Society of England*, Vol. 70, pp. 119–139.

uniform plan, and the results are published by the German Agricultural Society.

It may be remarked that trials are an essential part of any scheme, and the whole subject is dealt with below.

*Denmark.*—When reviewing Mr. Faber's book, "The Forage Crops of Denmark," in a previous number of this Journal, one of the present writers drew particular attention to that portion which explains how, in Denmark, there is practically no sale for Root-seed unless it has shown its superior value in independent field trials. The "Guarantee of Genuineness" now furnished by Danish Seedsmen also was the subject of special comment. So great has been the success of these two movements that, as far as Roots are concerned, all confusion in nomenclature has been completely eradicated; it is now intended that all other agricultural crops shall receive similar attention.

Whether "Guarantees of Genuineness" can ever be introduced into this country is a question which only the Seed-trade itself can decide, but it is worth pointing out that in Denmark the system originated on the initiative of the trade, and has become more and more popular with them ever since.

*Holland.*—The "Society of Agriculture of the State of Holland" undertakes the inspection of crops at all stages, from sowing to marketing, and issues a guarantee of seed which comes up to the requisite standard.

The farmer who desires to sell seed under this guarantee must obtain his original stock from a source recognised by the Society—either from a pedigree-seed producer of unimpeachable reputation, or from stocks previously approved by an Agricultural Society providing satisfactory guarantees of their value. The seed should reach the farmer in sacks sealed by the producers, when he must notify the Chief Inspector of the Dutch Society of the date and place of the proposed sowing. The Inspector verifies the origin of the seed and notes the land on which it is sown. The crop is subsequently examined just before harvest by an inspector and by two experts nominated by the Society, and is valued on a scale of points, as follows:—

| | | |
|---|---|---|
| Trueness to strain and variety ... ... | max. | 30 points. |
| Uniformity of height of plants ... ... | ,, | 20 ,, |
| Absence of weeds ... ... ... ... | ,, | 5 ,, |
| Absence of disease... ... ... ... | ,, | 15 ,, |
| General impression ... ... ... | ,, | 30 ,, |
| | | 100 |

For guarantee, the points gained must exceed 80, and the crop must earn 3/5 of the maximum under each heading. The finding of the Committee must be unanimous. Before the guarantee is actually given, the Society must be informed of date of harvest, of thrashing and of cleaning, each of which must be done in such a manner that admixture is precluded. The harvested seed is examined critically by the inspector, and if the result is favourable, the bulk is placed in bags and sealed with the initials of the Dutch Society, and with a number corresponding to that in the Society's register. A sample is taken and retained for reference after a small quantity has been sent for test at the Official Seed-Testing Station, the report of which is published in the journal of the Society. After this the seed can be sold as "Guaranteed."

*Other European Countries.*—As far as can be ascertained, the remainder of the European countries have devoted but little attention to the problem, and have so far confined their activities to an attempt to crowd out inferior varieties by propaganda in favour of those of proved worth, and by organising seed-growing societies among farmers through the agency of which seed of good varieties is disseminated throughout the country. These activities, though valuable, do not touch the root of the evil, and can only be regarded as auxiliary measures.

*Australia.*—A Seed Improvement Committee of the Commonwealth Advisory Council of Science and Industry was set up in 1917. Its chief terms of reference are:—

"To deal with (1) the nomenclature of cultivated varieties of farm crops, (2) the elimination of undesirable varieties of crops."

Wheat is the first crop to receive attention, and it was decided that the first thing to be done was "to publish a detailed description of every variety (of wheat grown in Australia) which can be taken as a standard, and to which any grower or breeder can refer in case of doubt." As a result of this, a bulletin containing a provisional classification and key has now appeared, and it is proposed to add to this from time to time. Other measures will follow in due course, but their nature and scope have not been published. Classifications or descriptions of wheat varieties have also been produced in South Africa and India.

*United States of America.*—In America, though it is widely recognised that the nomenclature both of agricultural and garden

plants leaves very much to be desired, little has been done by Federal legislation to bring about improvement. It appears that the truth is occasionally published concerning some of the most flagrant cases in which varieties are being sold under incorrect varietal names, but, in general, unless there is fraudulent exploitation, even this action is seldom taken. Even where such facts are published, little benefit can result, for in no cases are the names of the offending traders given save in the unique instance where such action is enjoined by Federal legislation. This last is in connection with the adulteration of certain grass-seeds where the law definitely directs that the names of the offenders shall be published.

Under the auspices of the United States Department of Agriculture, systematic botanists started, in 1903, to compile a classification of the wheats of the country, but so great was the confusion which they found to exist that the project had, temporarily, to be abandoned. This work has now been resumed by Messrs. Ball & Clark, who, as a preliminary step, presented a paper before a meeting of the American Society of Agronomy. They commence the paper by giving numerous examples of the chaos prevalent in the nomenclature of this crop, and then set forth a proposed code of nomenclature for consideration and adoption by this body as representing the interests concerned. A complete set of rules is set out, which even go so far as to control the type of name to be adopted by the originator, discoverer, or introducer.

Pure-line selections, hybrids, &c., which have superior merit, even though not distinguishable by external characters, are eligible, but unfortunately, the basis on which admission would be granted or refused in such cases is not explained.

Were it proposed, in England, to exercise an absolute control over nomenclature, these regulations would demand detailed study, but the present time is not auspicious for such a plan, nor does it appear desirable to go to this extreme until other means have been tried.

Apart from any action by the Federal Government, each State can take its own line in matters of Seed Control, and all except 15 have done so. Their general object is to make compulsory the labelling of all seed sold within the State, such labels usually have to state the kind of seed, the name and address of the seller, the purity, the germination, the place of origin and the percentage of specified noxious weed-seeds. A heavy fine is imposed should any information on the label be proved to be false.

To turn from agricultural to garden plants, much valuable work has been done lately. At the Annual Convention of the Vegetable Growers' Association of America in 1919 a committee was appointed to study the problem of vegetable nomenclature. A further committee with a similar purpose was appointed by the American Seed Trade Association at their 1920 Annual Meeting. These two committees held a joint meeting in October last at which certain lines of action were decided on which give promise of real progress in the solution of this difficult problem.

Previous to this joint meeting a questionnaire had been issued to members of the Association asking (1) whether they were in sympathy with an attempt to standardise the names of vegetable varieties, (2) whether they had any points to suggest in connection with form of name, spelling, provision for the identification of private strains of standard varieties, &c., (3) whether they would supply the Committee with a list of the varieties definitely understood to be renamed standard varieties, and also a list of the new varieties introduced by each firm which had been generally accepted as new varieties, (4) whether a transition period of one, two or five years should be adopted as the period during which renamed varieties should be followed in brackets by the Standard name, and (5) whether they would be prepared to forward trial samples of all new varieties to be tested and registered at an official trial ground at least one year in advance of their public introduction.

The replies to this questionnaire were very satisfactory and encouraging.

The joint committee decided that one of the first problems which presented itself was the necessity for collecting complete information with regard to the trade names and comparative market quality of the different vegetables and their varieties. It was clear that to obtain these particulars the assistance of a wide circle of competent persons would have to be enlisted. The Committee therefore grouped vegetables according to their natural relationship and twenty-one sub-committees of the leading authorities in the seed-trade of America were suggested as group committees. A plan of work was mapped out for these committees.

The joint committee also drafted a suggested code of vegetable nomenclature modelled on the code adopted by the American Pomological Society.

In addition to the controlling of the type of name to be adopted, the code lays down that there shall be a Board of

Registration (it is suggested that the Bureau of Plant Industry should undertake this work) whose duty it shall be to make and preserve records and descriptions of all existing valid varieties of vegetables, and to register such new varieties as may be submitted to them, provided they find them to be truly new and distinct. This Board is to have authority to issue a certificate to the originator of a new variety, and such variety is not to be catalogued or offered until such certificate has been issued.

The work of the 21 sub-committees appointed to give detailed study to certain groups of vegetables is said to be progressing in a very satisfactory manner.

Efforts are also being made to develop a system of field tests throughout the different parts of the United States, to be checked by some central committee, whereby the comparative value of strains as well as varieties can be determined.

This concludes our survey of the work being done in other countries, and not only does it confirm our contention that the situation in those countries is deemed to be so unsatisfactory as to justify drastic measures, but it furnishes us with most valuable suggestions concerning the methods which might with advantage be adopted in England towards the amelioration of our own situation.

**Proposed Remedies:—**

*Immediate Measures.*—We will first deal with the measures being taken by the American Vegetable Growers' Association just described.

There is much in this scheme which could be adopted in this country both for agricultural plants and for vegetables. Though it is essential that for the ultimate solution of the problem of nomenclature a complete system of yield and quality trials is the only possible basis, the organisation of such trials will take time, and there is a vast amount of preliminary work which can be begun forthwith, particularly in the direction of establishing an authentic list of existing standard varieties, which is a necessary preparation for the registration of new varieties. As to whether this preliminary work should be undertaken by the Ministry of Agriculture, the National Institute of Agricultural Botany or some other directing authority need not now be discussed.

In order to secure the requisite co-operation of the seed trade, any scheme for the limitation of the names of varieties should be of a purely voluntary nature.

The Directing Authority might in the first place invite all the leading wholesale seed houses to submit individual lists of the standard varieties of agricultural plants which they consider :—

(a) To have died out altogether, although the names are still "listed."

(b) To have been entirely superseded by better, new varieties.

(c) To be in no way different from, or to have degenerated to, the parent stock.

These lists should be amalgamated and submitted for the consideration of an expert committee, it being fully understood that the names of the firms submitting lists should in no way be disclosed in connection with their individual suggestions. From the amalgamated list a shorter (agreed) list might be selected and published as an "Official List of Synonyms." This would no doubt lead to quite an appreciable number of obsolete and unnecessary names of varieties being cleared off the market.

*Future Measures.*—Committees similar to the Potato Synonym Committee, but with wider functions, might be appointed to deal with each species of plant which is of agricultural (or market garden) importance. These committees must, however, be assisted by a most complete system of trials of yield and quality; for these physiological characters are after all of far greater importance to the grower than is any morphological feature such as beards on wheat or panicle shape of oats. It is essential that a broad view should be taken, and it should frankly be recognised that it is not of the least ultimate importance whether a production be a novelty or not unless, in some way, it is an improvement on its predecessors. From this point of view, these committees should discourage the naming of any variety or strain merely because it presents new characteristics. Merit should be the criterion, and on this proved merit such variety or strain should be granted admission to its appropriate Register, which should be kept by the organisation to whom power shall have been delegated to nominate these committees. The original entries into the respective Registers would be those existing standard varieties which had gained admission into the authentic list (mentioned above) compiled by the Directing Authority referred to above. As is the case in Germany, subsequent stocks would only be eligible on proof of conscious effort, culminating in improvement, continued over a series of years on the part of the producer.

This standard of merit obviously brings with it many difficulties. One is dealing with qualities which are not necessarily, or usually, correlated with any morphological character. No one, for example, on looking at an individual wheat plant of a variety unknown to him, can say whether its progeny will give a high or a low yield. As a result of long experience the expert can often recognise a variety and say: "This is Squareheads Master, it will give a bigger crop than that, which is Fife," but this prediction is only the result of constant trials of the two varieties, and not because any external character betrays the yielding capacity of the individual. Now it is certain that within any commercial variety there are individual stocks which possess capacity for yield, or for producing high quality grain, or for other valuable physiological qualities in a greater or lesser degree than the average, without betraying the fact except after prolonged test. The better stocks, when isolated, deserve encouragement; but if each small advance in useful physiological characters were considered to be a justification for a new name, instead of decreasing the number of names, it would be uncontrollably augmented.

There is obviously a distinction between these productions and those which combine improved qualities with morphological differences; and to mark that distinction it is suggested that the following definitions shall be adopted:—

*Variety.*—Any group of plants morphologically indistinguishable from one another, but morphologically distinct from any other plant or group of plants of the same species, shall constitute a variety.

*Strain.*—Any group of plants physiologically distinct from any other plant or group of plants of the same variety (as above defined) shall constitute a strain of that variety. The oldest known strain of a variety shall be termed the type.

It is proposed that only "varieties" as above defined should be entered into the Registers with distinct names, and that "strains" should be entered under the type name with the name of the originator or producer as a prefix, *e.g.*, "Brown's Essex Rough Chaff."

Should an originator claim to have produced a new, superior variety, it should be tested before admission to the Register, in competition with the best representative strains of at least two of the older varieties, and should only be entered as a new variety if both the above claims are proved correct.

In the case of a new strain, *i.e.*, where it is only claimed that an improvement has been made in yield, quality, or other non-botanical feature, the trial need only be made in regard to this quality against the best representative of the type to which the strain belongs, though any notable deficiency in any other good character would prevent admission to the Register.

Such trials must be carried out by experts, and would have to be repeated simultaneously on several different stations in different parts of England: the respective committees would weigh the evidence, and make their reports. These reports would be submitted annually to meetings of the interests concerned for confirmation, and would then be published. The reports might give, in addition to the mere findings, descriptions and illustrations of the varieties and strains which have qualified for the register; and a list of the original growers of the new registered varieties and strains, or of those to whom the whole of the original stock had been transferred.

The admission of strains to the Register, though essential, immediately creates a difficulty, for the fact that they are unrecognisable by eye from the other strains of the same type must tend to encourage fraud, as it would be impossible to detect the substitution of seed of inferior strains for that of the genuine article. That this form of fraud would not only be at the expense of the public, but also to the detriment of all honest traders, would suggest that the latter would have to co-operate to protect themselves. This brings us back to the Danish "Guarantee of Genuineness" which was evolved by the seed-traders themselves to meet this very difficulty in the case of roots. It would be a notable advance if this principle were adopted by traders in Britain, whose business it is to guard themselves, and to whose advantage it is to protect the public.

By the combination of trials and Registers everyone concerned, save those who deliberately make money by fraud, would be benefited; nomenclature would become rational and simple, and at the same time only the valuable productions would be encouraged at the expense of those which have no right to survive. The seed dealers would find their work simplified, the producers would, for the first time, receive an adequate return for their skill and labour, and the country would at last learn something about the crops which it grows.

# NOTES ON FEEDING STUFFS FOR MAY.

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**Rationing of Stock.**—Several correspondents have asked at various times, that analyses of feeding stuffs and their digestibilities might be included in these Notes. Owing to lack of space, and to the fact that such a table would necessarily be very incomplete, it has been impossible to accede to their requests. Their needs have, however, been carefully considered and it is hoped have been met by the publication by the Ministry of Miscellaneous Publication No. 32, entitled Rations for Live Stock, by Professor T. B. Wood. This publication, among other things, includes a table giving the chemical analysis and feeding value of all feeding stuffs likely to be used in farming practice, and will be found most valuable if used in conjunction with these notes. Copies may be obtained from the Ministry, price 6d. per copy.

**Rice and its By-products.**—The preparation of rice for human food gives rise to a number of by-products that find their way into the feeding stuffs market, either in the form of straight products or in the form of compound meals. In preparing rough rice for food, the outside tough hulls are removed and the rice kernels " polished " to give them an attractive appearance. These mechanical processes give rise to rice hulls, rice bran, and rice polish.

*Rice hulls* are tasteless, tough, and woody, and have practically no feeding value. Very often they contain a considerable proportion of sand or silica, and for this reason alone are dangerous to feed to stock. Owing to their unpalatability and poor feeding value they rarely find their way on to the market, except, in certain cases, in the form of compound meals. It should be unnecessary to state here, that reputable firms rarely employ this stuff as an ingredient to their meals.

*Rice bran* consists of the outer layer of the rice kernel and includes the germ, and should contain only a small percentage of the hulls. Such bran contains about 11 per cent. of oil and not more than 12 per cent. of fibre, and is a highly nutritious feed. It is useful for fattening steers, but should not be fed in very large quantities to dairy stock or pigs, since it tends to spoil the quality of the butter and produces soft pork.

| NAME. | Price per Qr. s. | Price per Qr. lb. | Price per Ton. £ s. | Manurial Value per Ton. £ s. | Food Value per Ton. £ s. | Starch Equiv. per 100 lb. | Price per Unit, Starch Equiv. s. | Price per lb. Starch Equiv. d. |
|---|---|---|---|---|---|---|---|---|
| Barley, English Feeding | 40/3 | 400 | 11 5 | 1 6 | 9 19 | 71 | 2/10 | 1·52 |
| ,, Canadian ,, | 40/- | 400 | 11 4 | 1 6 | 9 18 | 71 | 2/10 | 1·52 |
| Oats, English ,, | 44/- | 336 | 14 13 | 1 9 | 13 4 | 59·5 | 4/5 | 2·37 |
| ,, Foreign ,, | 39/6 | 320 | 13 16 | 1 9 | 12 7 | 59·5 | 4/2 | 2·23 |
| Maize, Argentine | 56/- | 480 | 13 1 | 1 5 | 11 16 | 81 | 2/11 | 1·56 |
| Beans, English spring | — | — | — | — | — | — | — | — |
| ,, ,, winter | 57/- | 532 | 12 0 | 3 1 | 8 19 | 66 | 2/8 | 1·43 |
| ,, Rangoon | 8/- | 112 | 8 0 | 3 1 | 4 19 | 66 | 1/6 | 0·80 |
| Peas, English blue | 58/- | 504 | 12 18 | 2 13 | 10 5 | 69 | 3/- | 1·61 |
| ,, ,, dun | 70/- | 504 | 15 11 | 2 13 | 12 18 | 69 | 3/9 | 2·01 |
| ,, ,, maple | 72/- | 504 | 16 0 | 2 13 | 13 7 | 69 | 3/10 | 2·05 |
| ,, Japanese * | 125/- | 504 | 27 16 | 2 13 | 25 3 | 69 | 7/3 | 3·88 |
| Buckwheat | 64/- | 392 | 18 6 | 1 9 | 16 17 | 53 | 6/4 | 3·39 |
| Rye, English | 55/3 | 480 | 12 18 | 1 8 | 11 10 | 72 | 3/2 | 1·70 |
| Millers' offals—Bran | — | — | 8 0 | 2 10 | 5 10 | 45 | 2/5 | 1·29 |
| ,, ,, Coarse middlings | — | — | 10 0 | 2 10 | 7 10 | 64 | 2/4 | 1·25 |
| Barley meal | — | — | 15 10 | 1 6 | 14 4 | 71 | 4/- | 2·14 |
| Maize ,, | — | — | 11 10 | 1 5 | 10 5 | 81 | 2/6 | 1·34 |
| Bean ,, | — | — | 16 10 | 3 1 | 13 9 | 66 | 4/1 | 2·19 |
| Fish ,, | — | — | 21 0 | 7 12 | 13 8 | 53 | 5/1 | 2·72 |
| Linseed | — | — | — | — | — | — | — | — |
| ,, Cake, English | — | — | 19 7 | 3 12 | 15 15 | 74 | 4/3 | 2·28 |
| Cotton seed ,, ,, | — | — | 12 0 | 3 5 | 8 15 | 42 | 4/2 | 2·23 |
| ,, ,, decorticated * | — | — | 18 10 | 5 6 | 13 4 | 71 | 3/9 | 2·01 |
| ,, Meal decorticated | — | — | 13 0 | 5 6 | 7 14 | 71 | 2/2 | 1·16 |
| Coconut cake | — | — | 10 0 | 3 0 | 7 0 | 79 | 1/9 | 0·94 |
| Groundnut cake | — | — | 11 10 | 3 9 | 8 1 | 57 | 2/10 | 1·52 |
| ,, ,, decorticated | — | — | 16 5 | 5 5 | 11 0 | 73 | 3/- | 1·61 |
| Palm kernel cake | — | — | 6 15 | 2 1 | 4 14 | 75 | 1/3 | 0·67 |
| ,, ,, meal | — | — | — | — | — | — | — | — |
| Brewers' grains, dried, ale | — | — | 7 12 | 2 7 | 5 5 | 49 | 2/2 | 1·16 |
| ,, ,, wet ,, | — | — | 1 15 | 0 12 | 1 3 | 15 | 1/6 | 0·80 |
| Distillers' ,, dry | — | — | 11 0 | 2 16 | 8 4 | 57 | 2/11 | 1·56 |
| ,, ,, wet | — | — | — | — | — | — | — | — |
| Malt culms | — | — | 6 15 | 3 6 | 3 9 | 43 | 1/7 | 0·85 |
| Potatoes† | — | — | 3 0 | 0 8 | 2 12 | 18 | 2/11 | 1·56 |
| Swedes† | — | — | 1 6 | 0 5 | 1 1 | 7 | 2/11 | 1·56 |
| Mangolds† | — | — | 1 3 | 0 6 | 0 17 | 6 | 2/11 | 1·56 |
| Vetch and oat silage† | — | — | 2 16 | 0 15 | 2 1 | 14 | 2/11 | 1·56 |

* Prices at Liverpool. † Farm value.

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of March and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative prices of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, suppose palm kernel cake is offered locally at £10 per ton. Its manurial value is £2 1s. per ton. The food value per ton is therefore £7 19s. per ton. Dividing this figure by 75, the starch equivalent of palm kernel cake as given in the table, the cost per unit of starch equivalent is 2s. 1d. Dividing this again by 22·4, the number of pounds of starch equivalent in 1 unit, the cost per lb. of starch equivalent is 1·11d. A similar calculation will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own market.

*Rice polish* has a feeding value approximately equal to maize, but is rarely found on the feeding stuffs market as it has a commercial value apart from its feeding value.

**Errata.**—In the issue of this Journal for April, p. 87, the following were stated in error:—

Line 14, "whole of the maize" should read "hulls of maize."
Line 19, "whole bran" should read "hull bran."
Line 29, "whole grain" should read "hull, germ."

**Entertainment Tax and Agricultural, Horticultural, Poultry and Rabbit Shows.**

There appears to be some misunderstanding as to the conditions under which exemption from Entertainments Duty is granted in respect of Agricultural, Horticultural, Poultry and Rabbit Shows.

The Ministry has been in correspondence with the Commissioners of Customs and Excise in this matter, and is informed by the Commissioners as follows:—

"All such Shows are 'entertainments' within the meaning of the Finance (New Duties) Act, 1916, and therefore Entertainments Duty must be paid unless the Commissioners of Customs and Excise have granted a Certificate of Exemption.

"Where it is desired to claim exemption, an application must be made to the Commissioners of Customs and Excise, Custom House, London, E.C.3, not less than seven days before the Show, accompanied by copies of the Rules and last Balance Sheet of the Society and Programme of the Show.

"If a Certificate of Exemption is not received before the Show, Entertainments Duty must be paid, as stated above.

"It may be added that, irrespective of any other objection, exemption cannot be granted if the proceedings are to include any extraneous attraction, such as a band, sports, fireworks, &c."

**Sugar Beet in England: Prospects for 1921.**

HOME Grown Sugar Limited, the Company in which the Ministry holds half the share capital, has now closed its list of contracts with farmers who have agreed to grow sugar beet during the present year. The capacity of the factory is 60,000 tons of beet or 600 tons per day for 100 days, but acting on the advice of their French specialists, the management have limited the tonnage for the first year to 20,000 so as not to overload the factory at a time when the machinery is new, and the English staff to be employed are being trained under the French specialists appointed to supervise each process.

The farmers in Nottinghamshire and Lincolnshire, to whom beet is a new crop, have shown the necessary enterprise, and therefore, it would have been possible to have doubled the acreage actually contracted for; indeed, many such contractors are growing a smaller acreage than they had wished. There are 425 farmers with an average of 5½ acres under cultivation. The 20,000 tons expected from the 2,365 acres contracted for will be despatched from 156 railway and barge stations, and a large tonnage will also be transported by road. For the reasons stated above, only 200 acres are being grown on the Kelham Estate, instead of the 400 originally contemplated. The price is £4 per ton delivered at the factory, which is equivalent to £3 7s. 6d. delivered on rail, and this price was fixed after careful calculation of costs, so as to give an incentive to the grower during the first year to make a speciality of his beet crop, devote his best attention to it, and not limit his expenditure on fertilisers, cultivations and supervision—all of which have a material effect upon sugar content as well as yield.

According to the figures of the test crops on the Kelham Estate last year, the cost per acre of 12 tons delivered on rail was £29 3s. 4d., and the sugar content averaged over 20 per cent. on the crops with a complete manurial dressing.

A silver cup has been offered by the British Sugar Beet Growers' Society, which promoted the present Company and has been assisting in the propaganda among farmers. It is to be competed for each year by growers of 10 acres and upwards, and the competition will be confined this year to growers for the Kelham factory. In this competition sugar content secures the largest number of points.

It now appears certain that in spite of the shortage of

bricklayers and the difficulties of the present abnormal times the factory will be ready by the autumn. The roof is now being put on the main portion of the factory and a large part of the plant has arrived from the machinery contractors, the Compagnie de Fives-Lille, the well-known French sugar engineers. French specialist erectors will supervise the erection by English workmen.

The public should realise that the real commercial test of a new industry is when you have arrived at the point where the raw material is of the best quality, and is being secured from experienced farmers, so that the factory is working with a complete economic supply under the best factory conditions, viz., full time with trained labour. This point cannot be arrived at in the first or second year, but the main essentials have already been secured, namely, a new factory planned on the most modern lines, and a list of growers whose experience in farming under British conditions is of a high order.

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**The Co-operative Dairy Movement in Working Order.**

SUGGESTIONS have been made from time to time to the effect that the Co-operative Cheese Schools started by the Ministry have not proved economically sound, and that the result of their efforts has involved those concerned in loss. This, of course, is very far from being the truth. Of the letters which have been received at the Ministry by those responsible for the working of Co-operative Cheese Factories, one dealing with a considerable undertaking in Denbighshire is typical and may be selected for quotation.

The work of this particular Co-operative Cheese Factory started in 1917 as a Co-operative Cheese School with a loan from the Ministry of utensils and the services of a competent cheese-maker instructor. The local farmers interested in the scheme provided a suitable building and undertook to send in the necessary amount of milk. The school worked for 106 days during the season of milk surplus, and handled upwards of 20,000 gallons of milk, the turnover being rather more than £1,350. The experiment was so successful from every point of view—farmers receiving more money for their milk and a profit on their cheese—that those who had taken part in the first year's endeavour formed themselves into a registered co-operative society with a modest capital of £400. The returns for the years 1918, 1919 and 1920 are now recorded, and the

figures are as follows:—In 1918, 34,000 gallons of milk were dealt with, 16 tons of cheese made and the total turnover £3,100. In 1919, 46,000 gallons of milk received, 21 tons of cheese made, turnover £4,600. In 1920 approximately 60,000 gallons of milk were received and 30 tons of cheese made, with a turnover of £6,000. The cost of production of cheese has worked out at less than 1½d. per gallon of milk dealt with. The Secretary of this thriving factory states that the co-operators are not only perfectly solvent, but that they have put by a good reserve, and find a ready market for their products.

The Society referred to works in a Welsh village 10 miles from the nearest railway station, 500 feet above sea-level, and in the years of its working has produced 80 tons of cheese in a district where none was produced before. The Secretary who supplied figures, which are open to the strictest investigation, has made enquiries at some 30 other centres and finds that his society's effort is not more than an average one. There are others in his district which have done even better, and in the few cases where success has not been achieved, it has been admitted that the management and not the system is at fault. This cheese-making industry is apparently a benefit to the wives and daughters of farmers who live in the wilds. It has saved all the single churnings that were a feature of the life of every farm, and the trouble of marketing the produce, while the consumer is supplied with produce of a uniform standard quality.

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**Phosphatic Manures: The Present Position.**

SINCE the beginning of the year the Agricultural Press has been emphasising two aspects of the supply of phosphatic manures. They are (1) that although official figures show a considerable increase in the production of basic slag it is likely that there will not be sufficient this season to meet the total demands of the farming community; (2) the fact of the production of superphosphate being in excess of the present demand for it may result in large quantities being exported, on account of the congestion at the works. It is natural for the farmer to enquire how these conditions are likely to affect him, and what he should do to meet them.

Three courses present themselves. The first is to discriminate in the use of basic slag. Requirements per acre are greater now than they have been, because the grades of slag quoted

range roughly from 16 to 32 per cent. total phosphates; few range above that figure, and several are below it. When it is remembered that a few years ago high grade slags approximated to 40 per cent. total phosphates, it is obvious that dressings of a 20 per cent. slag must be doubled in quantity to effect the same improvement. Industrial conditions resulting in short time being worked in the steel works may prove a further factor in limiting output. It would seem important, therefore, to confine the use of slag mainly to grassland, and make up the phosphates required elsewhere by dressings of other manures. There are cases where slag appears to confer no benefit on poor pasture, and it seems questionable whether, where that is so, any other form of phosphatic manure would do better. It is worth mentioning, however, that an absolute lack of potash in some soils may prevent any visible result from dressings of phosphates, while on other soils a rough, matted and fibrous covering greatly handicaps the slag in reaching the soil. A very thorough harrowing is imperative to set this condition right.

The second consideration is the possibility of substituting superphosphates for basic slag in order to take advantage of the state of supplies. Local experience or experiment may prompt the use of superphosphates on grassland in place of slag. Approximately 5½ cwt. of 35 per cent. superphosphate equals a dressing of 5 cwt. high-grade basic slag. Generally, superphosphate may be substituted where it has been customary to use slag in cropping; the former is more rapid in action and thus, as a rule, better suited to arable farming. In consequence of this rapidity, its maximum effect is more quickly reached, but where seeds are only down for one year, the influence of this manure applied to the nurse crop will be all that is required. Where there is hesitation to substitute superphosphate for slag altogether, the two may be mixed. Superphosphate will act rapidly on soil with a good lime content.

Thirdly, there is the use of phosphatic manures other than those already discussed. A review of experiments conducted in this country shows that finely ground mineral phosphate is valuable in the north of England and also in Scotland and in Wales. Good results have also attended its use in Essex, and has been applied also with benefit in other districts, notably in those with a high rainfall, and on soils rich in organic matter.

The following is a brief résumé of some of the more important experiments of which records are available:—

Aberdeen 1905–1907, Turnips, Barley, Hay.

In a series of experiments extending over 3 years, the effect of different forms of phosphate, viz., superphosphate, basic slag, bone meal and ground Florida phosphate applied alone and with dung was tested on turnips followed by barley and hay. In the "no dung" plots, both super and slag gave somewhat better returns than mineral phosphate, but when dung was used the mineral phosphate gave the greatest total value of crops and considerably the highest profit.

Experiments in *North Wales* also indicate that rock phosphate is distinctly effective. At six centres the yields of swedes were, on the average of three years 1913-1915, per acre:—

| | *Tons.* | *Cwt.* |
|---|---|---|
| No phosphate ... ... ... ... ... | 13 | 1 |
| * Basic Slag (482 lb.) ... ... ... | 22 | 4 |
| * Gafsa phosphate (333 lb.) ... ... ... | 21 | 8 |
| * Superphosphate (539 lb.) ... ... ... | 22 | 9 |

* All contained 200 lb. of phosphate.

These manures are being quoted at a low unit value at present. A mixture of finely-ground soft mineral phosphates and superphosphates may be employed for arable crops. The following quotation from an article by Dr. Russell* summarises the position with regard to mineral phosphates: "*Where basic slag cannot be obtained in sufficient quantity, it is worth while trying mineral phosphates, provided that they are sufficiently finely ground.*" Their cheapness suggests use on rough pasture, especially the poorer, high-lying types rented at a figure which makes dressing with slag out of the question. Bone meal, and especially steamed bone flour, have been showing a cheap unit value of late; both contain a little nitrogen, and may with advantage be mixed with superphosphate.

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**Potato Synonyms: Report of the 1920 Committee.**

THE whole of the potato industry in this country is affected adversely by the unfortunate habit acquired by certain growers of describing as distinct varieties potatoes that present under careful examination similar conditions of flowering, foliage, growth habit, stem colour, size, shape and colour of tuber, together with identical physiological characteristics. A Committee of the National Institute of Agricultural

* This *Journal*, Jan., 1921, p. 963.

Botany has made investigations on the trial grounds of the Potato Testing Station at Ormskirk in Lancashire, limiting its work to the examination of potatoes not previously tested on the Ormskirk ground for immunity. Four visits were paid—in July, August and October of last year—and 242 varieties of potato alleged to be distinct were tested. Of these, 150 varieties were found to be indistinguishable from one or other of 35 well-known trade varieties; the whole of the 242 were classified in 42 groups. The Committee came to the conclusion that the great majority of synonymous varieties are indistinguishable from popular varieties, and that as soon as a new immune variety appears and achieves popularity, " new " sorts which are new only in name and are indistinguishable from the variety that has achieved popularity spring up at once. As a rule these synonymous varieties of potatoes fall readily into two classes, and the method of classification adopted by the late Mr. Snell, whose great work for the potato industry will never be forgotten, cannot be improved upon. One class comprises those few very familiar types, such as Up-to-Date, Abundance, Great Scot, King Edward and others that are at present in commerce, while the rest are related to half-forgotten varieties, such as Cardinal, Early Rose and Nonsuch class. The best that can be said of the latter is that two established varieties, Edzell Blue and Early Market, may be said to have sprung from it. The Committee does not feel called upon to decide whether these synonymous varieties are actually new growths or whether they are the product of ignorance, carelessness or fraud, but it feels very strongly that the practice of putting synonymous varieties on the market is at once harmful to the good name of the trade and detrimental to the efforts of the National Institute of Agricultural Botany. The carelessness of certain members of the trade is shown in other ways. For example, it is stated that two potatoes quite distinct from each other were introduced by the same firm and under the same name at an interval of rather more than ten years. One was susceptible to Wart Disease; the other immune, and both were indistinguishable from known and established varieties.

It is to be hoped in the interests of the potato industry, which after all is a large and important one, that this report of the Potato Synonym Committee will be widely read and carefully considered. Published at the National Institute of Agricultural Botany at Huntingdon Road, Cambridge, it costs 1s., but applications for copies should be made to the Secretary

at the temporary offices, 10, Whitehall Place, London, S.W.1. The report was submitted in February last to the Potato Industry Conference recently instituted by the National Institute of Agricultural Botany. This Conference represents the Ministry of Agriculture, the Institute of Agricultural Botany, agricultural and trade associations and the leading growers and merchants. All approved the Report and recommended its publication.

**Foot-and-Mouth Disease.**—*Yorkshire (E. Riding).*—No outbreak has occurred in this district since that confirmed on the 1st March last, referred to in the March issue of the *Journal*, and all restrictions have been withdrawn.

*Derbyshire.*—The existence of Foot-and-Mouth Disease on premises at Draycott, Derbyshire, was confirmed on Sunday, the 27th March, in four out of nine Irish heifers consigned from County Limerick, which had been landed at Holyhead via Dublin on the 23rd March. Apparently no symptoms of the disease appeared until the 25th March, when the Veterinary Inspector of the Local Authority examined these animals on arrival at Draycott, in accordance with the provisions of the Order of the Ministry under which the animals were landed from Ireland.

In view of the fact that the origin of the disease was definitely established, it was not considered necessary to impose restrictions over an area with the usual 15 miles radius, but to limit the district to one with a radius of about 5 miles around Draycott.

*Birkenhead and Holyhead Irish Animals Landing Places.*—The existence of Foot-and-Mouth Disease was also confirmed in Irish animals detained at Birkenhead Landing Place on the 29th March, and at Holyhead Landing Place on the 2nd April. These animals were under detention as a result of the existence of disease being confirmed in the Irish animals at Draycott.

The landing of animals in Great Britain from Ireland was entirely prohibited on the 28th March, and special steps were taken to trace all animals which might have been exposed to infection by reason of contact with the animals concerned in these three outbreaks, and at the time of going to press no further outbreak had been confirmed in any part of Great Britain.

*Norfolk.*—The existence of Foot-and-Mouth Disease was confirmed on the 9th April on premises at North Runcton, Kings Lynn.

*Chester.*—On the 16th April, the presence of the disease was also confirmed on premises at Bebbington, near Birkenhead.

In the former case, restrictions were imposed over the usual radius of 15 miles from the infected premises, but in the latter, which occurred in the Wirral Peninsula, the estuaries of the Rivers Dee and Mersey afforded effective natural boundaries, and it was not considered necessary to include all the country within the radius of 15 miles which lies beyond these rivers.

**Rabies.**—*Wiltshire, Dorset and Hampshire.*—Two further outbreaks of Rabies have occurred in this district since the April issue of the *Journal*, viz., on the 23rd March at Southampton and 4th April at Farley-Chamberlayne, near Romsey. No alteration has been necessary in the limits of the existing muzzling area on account of these cases.

*Glamorgan and London.*—No further cases have occurred in these areas.

*Berkshire District.*—A further outbreak of Rabies was confirmed (after inoculation experiments) at Stokenchurch, near High Wycombe, Bucks, on the 15th March, in a dog which was destroyed on the 28th January.

**Sale of Gooseberries.**—The Ministry desires to inform growers of gooseberries, salesmen and others interested in the trade in gooseberries, that all restrictions on the sale of home-grown gooseberries affected with American Gooseberry Mildew have now been removed. The restrictions previously imposed, to the effect that gooseberries affected with this disease might only be sent to Jam Factories, are now revoked, and in future any gooseberries fit for human consumption may be sold freely in any market or shop.

**Importation of Gooseberries: Issue of a General Licence.**—Under the American Gooseberry Mildew (Importation of Fruit) Order of 1919, gooseberries may only be landed in England and Wales under licence issued by the Ministry. It has been decided that, during 1921 and until further notice, gooseberries may be so landed provided that they are accompanied by a certificate of freedom from American Gooseberry Mildew issued by a duly authorised official of the country of exportation. A General Licence authorising the landing of gooseberries subject to this condition has been issued accordingly.

Importers of gooseberries should, therefore, note that they will no longer be required to obtain individual licences from the Ministry, but that they must make certain when purchasing gooseberries from abroad that the required certificate of freedom from disease has been issued in respect of the fruit purchased. If such certificate does not accompany any consignment, its landing in this country will not be permitted by the Customs Authorities.

**Livestock Improvement: The Ministry's Grants in Aid.**—It is vital to the welfare of agriculture that the livestock of this country be improved, and steps are being taken by the Ministry to secure this end. The necessity for livestock improvement rests upon three main considerations:—(1) that if the farmer is to pull his weight he must have the best material; (2) the difference on sale value between first class stock and the rest is enormous; and (3) no unthrifty animal can pay its own expenses, to say nothing of those of its master. These arguments are obvious, but there can be no harm in reiterating them in order to bring the question urgently home to all concerned. Deep interest is taken by the Ministry in the whole problem, and it is desired to make improvement practical. Consequently, as part of the Improvement of the Live Stock Scheme which has been in operation for some years, grants are made by the Ministry under certain conditions to:—

*(a)* Societies maintaining approved Bulls.
*(b)* Heavy Horse Societies travelling approved Stallions.
*(c)* Societies or individuals maintaining approved Boars.
*(d)* Milk Recording Societies.

Full particulars as to the grants made for Bulls, Heavy Horses, Boars, and to Milk Recording Societies can be obtained from the Ministry's Leaflet No. 282.

**Tractor Trials, 1921.**—The Society of Motor Manufacturers and Traders have arranged to hold their trials this year at Shrawardine, near Shrewsbury, during the week commencing the 19th September. The entries will be classified as follows:— (*1*) Farm tractors for direct traction ploughing and

belt work (internal combustion); (*2*) Farm tractors for direct traction, ploughing and belt work (steam); (*3*) Self-contained motor ploughs and cultivating implements; (*4*) Cable ploughing sets (internal combustion engines); (*5*) Self-propelled garden ploughs and cultivators; (*6*) Tractor ploughs; (*7*) Tractor Cultivators; and (*8*) Disc Harrows. It is to be observed that for the first time in this country separate classes have been allotted to tractors adapted for horticulture work and to tractor implements. It is proposed to have a six hours' continuous ploughing test during the trials, which, unlike those held last year by the Royal Agricultural Society and the Society in conjunction, will be non-competitive.

**Export of Live Stock to Uruguay.**—As a result of representations made by the Ministry through the Foreign Office, regarding the restrictions on the export of Live Stock from this country to Uruguay, the Government of Uruguay have reduced from 6 to 3 months the period that a county must have been free from Foot-and-Mouth Disease before a certificate for the export of stock from that county to Uruguay can be issued by the Ministry.

**Warning to Poultry Keepers.**—Recent reports to the Ministry show that deaths have occurred among poultry kept in houses or runs, in the construction of which discarded aeroplane wings or fabric have been used. Owners of the poultry are of opinion that their birds have been poisoned either by picking off the "dope" or dressing from the aeroplane wings or fabric, or by the effect of vapour that is given off at times from the "dope" itself. After careful investigation of certain cases and subsequent enquiry, the Ministry desires to draw the attention of poultry keepers to the undoubted risk of loss that attends the keeping of poultry in houses or runs constructed wholly or in part of aeroplane wings or fabric. It is believed, however, that there is little, if any, risk if these materials are well tarred. Lime must not be used on any account as it would prove destructive to the fabric.

# ADDITIONS TO THE LIBRARY.

## Agriculture, General and Miscellaneous.

*Memoirs of the Geological Survey.*—Special Reports on the Mineral Resources of Great Britain. Vol. vii. :—Mineral Oil, Kimmeridge Oil-Shale, Lignites, Jets, Cannel Coals, Natural Gas. England and Wales. (2nd Edition), (125 pp.). London: H.M. Stationery Office, 1920, 5s. net. [55 : 912.]

*Memoirs of the Geological Survey.*—Special Reports on the Mineral Resources of Great Britain. Vol. xiii. :—Iron Ores (contd.), Pre-Carboniferous and Carboniferous Bedded Ores of England and Wales. (123 pp.) London: H.M. Stationery Office, 1920, 7s. 6d. net. [55 : 912.]

*Kent Education Committee; Agricultural Education Sub-Committee.*—Notes on Demonstration Allotments and Potato Trials, 1920. (24 pp.) Maidstone, 1920, 6d. [63.512(04); 37(072).]

*Collier, D.*—Basket-Making. (152 pp.) London: Cassell & Co., 1920, 1s. 6d. net. [63.193.]

*Texas Agricultural Experiment Station.*—Bull. 223 :—Effects of Lime and Carbonate of Lime on Acid Phosphate. (16 pp.) College Station, 1917. [63.1672.]

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